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JOSEPH ERNST VON BANDEL.

THE ARMINIUS MONUMENT AND ITS BUILDER.

GERMANY may be called the land of monuments. Every important city has a number of statues, many of which are works of the highest art and sources of attraction to the tourist. Since the year 1871 there is scarcely a hamlet without its "Kriegsdenkmal," or monument erected to the memory of the soldiers who fell in the Franco-German war, of more or less architectural beauty and significance. Berlin has recently erected in the Thiergarten its striking monument of Victory, crowned by a beautiful gilded figure of the goddess, while around the shaft are skilfully fastened cannon taken during the recent campaign; and underneath, in a circular, temple-like structure surrounding the base, is a beautiful mosaic picture; and on the sides, bronze reliefs, representing the most important events of the war.

The monument of Frederick the Great, situated opposite the Emperor's palace, on the Linden, is one of the finest of its class in Germany. Frankfort-on-the-Maine has its statues of Goethe, Guttenberg, and Schiller. Munich has the colossal statue of Bavaria, and those of scores of poets, philosophers, and warriors who have gained fame sufficient to have their effigies fashioned in bronze or marble, at the command of the art-loving monarchs of that little kingdom. Worms has its Luther monument, to which travellers from all Protestant lands make pilgrimage. The Rhine is eventually to have one of the most splendid monuments in Germany, if the plan now entertained of erecting a statue on the Niederwald, the heights nearly opposite to Bingen, at a cost of half-a-million of thalers, be carried out.

Last year another of these evidences of the regard paid by Germany to the memory of her heroes was added to the thousand which already existed. It was unique in character and interesting on account of its builder and the place where it was erected—a majestic, solitary, colossal, heroic figure, overlooking miles upon miles of the forest-clad mountains of the Teutoburger Wald. It stands with uplifted sword, telling Germany of the glorious deeds of a long-gone past. In August, 1875, the erection of the colossal monument of Hermann, or Arminius, on the Grotenburg, the highest peak of the Teutoburg range, was finished. This height overlooks the ground where, in the year 9, over eighteen hundred years ago, Arminius and the united German hosts defeated and slew the forces of Varus, the Roman general sent by the Emperor Augustus to subjugate the Teutons.

The statue is the largest of its kind in Germany. That of

Bavaria, on the Theresien-Wiese in Munich, can alone be compared with it; but the Armin monument, besides being a nobler structure, is of far greater interest, because of its history; for while "Bavaria" was called into existence by the will of a king who had millions at his command, the statue of Hermann is the creation, and in part the handiwork, of a single individual, who was inspired with the idea of building it when a mere boy, and who, now a man of seventy-five, with grey hair and faltering steps, has lived to see his great work completed, and to witness the appreciation, so long withheld, of his countrymen, after he had struggled manfully for thirty-seven years. The name of the sculptor is Joseph Ernst von Bandel, whose portrait we give with this article. Of him and his work we intend to speak. But first let us glance at the history and legend of the hero whom Von Bandel selected as the subject for his colossal structure on the Grotenburg, a hundred and eighty feet in height, higher than the column of Antoninus on the Piazza Colonna in Rome, higher than the Nelson monument in Trafalgar Square, but placed amid surroundings of very different character—amid the solitude of the forest whose gloom still conceals the traces of Hermann's deeds and of the great defeat of Varus.

Hermann's life leads us back to the commencement of the Christian era. Before the birth of Christ, he was a prince of the Teutonic tribe of the Cheruscans, and in the year when Christ was born stood in all probability among the German auxiliaries in Rome. In the year 9, he united the German tribes, who could no longer endure the tyranny of the Roman yoke, and fought, somewhere near the city of Detmold, a very short distance from the mountain now crowned with his monument, a terrible three days' battle with Varus and his legions, which he almost annihilated, and thereby for ever stopped the northward progress of the Romans in Germany. Tacitus has left us a noble tribute to the hero: "Hermann, or Arminius, was undoubtedly the liberator of Germany. He contested with the Roman empire in the period of its greatest power; and though in battle not always the victor, yet he was never defeated. He died when thirty-seven years old, having ruled among his people for twelve years. His fame is yet sung in the songs of his country."

Hermann was a son of Sigismar, a prince of the Cheruscans, and received a military training in the camps of the Romans, who, under Drusus, Tiberius, and especially Sentius Saturninus, had succeeded in bringing into apparent allegiance most of the tribes of north-western Germany.

In the year A.D. 6, Quintilius Varus had chief command in northern Germany, and by his reckless method of dealing with the Germans, and his harsh execution of the law, raised up a spirit of rebellion of which Hermann became the leader. Hermann secured in secret the co-operation of the Bructerii, the Marsii, the Chatti, and the Sigambri. Varus left his winter quarters at Aliso in the spring of the year 9, and encamped in the neighbourhood of Minden. In September of the same year, when the rainy season was approaching, he received news of the rebellion of a tribe dwelling to the south, probably the Chatti. He determined to make a short campaign, and punish the rebels at once, and proceeded with his three legions (XVII., XVIII., and XIX.) and a large army of camp followers, towards Aliso, followed by the German princes, with the auxiliary troops. Hermann gradually allowed the unsuspecting general to get ahead, the signal was given, the tribes gathered, and in the valleys and ravines of the Teutoburger forest, where the Romans became inextricably confused, the Germans commenced their attack.

The legions were taken completely by surprise; they were terrified at the sight of the thousands of horn-capped Germans who were shouting and yelling on all sides, while, to add to the confusion, the rain fell in torrents, the storm howled in the tree tops, the bows of the archers became useless, and the clay soil clogged as with lead the feet of the Roman legions. The Germans believed that Odin and his invisible army were with them, riding on the storm. After the first day's conflict the Romans managed to reach an eminence, where they encamped for the night, after throwing up defences and burning their waggons and baggage. On the second day they had to pass through more gloomy forests and ravines; the Germans increased in numbers, their attacks were more fatal, and at night the Romans encamped weary and disheartened. The third day broke; the storm raged yet more violently; the legions could make scarcely any progress on the slippery ground; they were again attacked and fell by thousands. At last they ceased to resist, were cut down as they stood, and only a few cavalry escaped the carnage. Varus and many other leaders cast themselves upon their swords, and so ended their disgrace. The Germans took terrible retribution for what they had suffered. The prisoners were offered upon the altars in the sacred groves, the officials who had administered the so-called Roman justice to them were mutilated in every imaginable form, and the head of Varus was dispatched by Hermann to Rome. The hero then addressed the Germans from an eminence, and, pointing to the conquered trophies, told them they were free once more. It is well known how the terrible news was received in Rome, and how poor Augustus, in an agony of shame, exclaimed, "Varus, Varus! give me back my legions!"

Several attempts were made to punish the Germans, but Germanicus nearly suffered the fate of Varus, when collecting the bones of the Varian legions. Twice afterwards he attacked, and indeed vanquished the Germans; but eventually he was compelled to retire, and Rome thenceforward directed her attention to the defence of her frontiers on the Rhine and the Danube. Hermann finally became the acknowledged chieftain of a confederation of the North German tribes; but was, in the year 21, foully murdered by some of his own kinsmen, who had become jealous of his growing power. Some historians think that he had endeavoured to assume royal powers and dignities, but this is not probable, as in the year 47 we find a deputation from the Cheruscans in Rome, asking that Italicus, the son of Flavius, Armin's brother, who had always been in the service of Rome, should return with them and become their chief, since he was the last of Hermann's blood.

Hermann came in time to be considered a divinity; song and fable had, in the lapse of ages, confounded the distinctions of truth and fiction, till the historical was lost in the mythological hero. Celestial attributes were not wanting to his glory. The Irmin waggon was watched in the heavens with silent awe as it wheeled round in its eternal course. In the eighth century the Irminsül, an idol or pillar in honour of some god or hero, stood in a sacred grove in this Forest of Teutoburg, where for ages it had been worshipped by the pagan Saxons, until Charlemagne destroyed it. From that time until 1514 Armin was forgotten by his people, until the discovery of the first five books of the "Annals of Tacitus," in the library of the Abbey of Corbei, on the Weser, in the heart of the Cheruscan land, where the hero had delivered his people from tyranny. As the historian remarks, "Many a laborious hour has been devoted to his history; antiquaries have laboured to trace his slightest footstep, poets have sought inspiration from his name, and a new Irminsül, of colossal dimensions, has recently been reared on the highest peak of the Teutoburger Wald; but the worthiest tribute to the hero's memory is the work of Tacitus. The modern Irminsül may perish like the ancient one, the songs of the day, like the canticles of old, be forgotten; but the *Liberator haud dubie Germaniæ*, the noblest epitaph ever devoted to a mortal, will endure so long as Germany shall prize her national independence, as if it were graven with an iron pen and lead in the rock for ever."

Having thus given a necessarily short and imperfect sketch of the ancient German hero, let us glance at the interesting life of the aged sculptor and patriot, to whom Germany owes not only the Hermann monument, but also the interest which has been aroused in the ancient hero. The conception was not entirely new, for the Landgrave Frederick Ludwig, the great-grandfather of the present Prince of Lippe, had discussed a similar project with Klopstock almost a century ago. But the work was left for Von Bandel to begin and to complete. Joseph Ernst von Bandel was born in the year 1800, at the little city of Anspach, in Bavaria, in the period when Germany was under the yoke of a foreign power, and his boyhood fell thus in the eventful period that marks the commencement of the present century; and although his youth prevented him from taking an active part in the struggle against French supremacy in Germany, the great events left their impression upon his mind. He says that during the time of the War of Liberation, he was first impressed with the idea of his fatherland's greatness. When he "saw the German sword again upheld in its true dignity, and around it gathered the races of Germany once more," then it was that he seized the idea of crowning upraised and united Germany with the colossal monument to the earliest hero of his fatherland's freedom and unity, as recorded in the annals of history. The old man of iron grey was a mere boy then, but the thought gained shape and being with the boy's development. That early idea is now a reality.

Von Bandel went to Munich in 1816, to enter as a student of art in the Academy. He finally adopted sculpture as his life's work. In the years 1821 and 1822 he carried out, at the command of King Max, the restoration of the Schœner Brunnen at Nuremberg. He afterwards chiselled in Rome a bust of Franz von Sickingen for King Ludwig I. of Bavaria. In 1827 he married Caroline von Kohlhagen, the daughter of the burgomaster of Nuremberg. Two years later, in the midst of his ordinary labours, he began to think of carrying out the old idea of a monument to Armin in the forest of the Teutoburg. After showing to Schorn a plastic sketch, who acknowledged it as a figure of the hero in its intended significance, he was called away to Hanover and Göttingen. At the latter place he furnished for the University the model of a statue for King William IV., and executed a number of smaller works in

marble, noted for their tenderness and loveliness. Returning to his old hero in 1834, he completed a model, 4 ft. high, after his original sketch, and placed it in the German exhibition of that year. Two years later, while in Hanover, he made another model, 7 ft. high, and this one is now carried out in colossal proportions on the summit of the Grotenburg. Thus is developed in 1819, the idea preserved in pencil; in 1830 the first small model; in 1834, the enlarged model; in 1836, the model for Detmold; in 1875, the triumphantly completed work! It would of course have been an impossible task to make the statue a likeness of the German hero. Von Bandel wished rather to symbolize in an *ideal* Hermann "Hermann's deed, his 'Schwerterhebung'—his upraising of the sword—to which is attached the idea of German being, German might, German glory, and German unity."

For his hero, Von Bandel determined to find a noble resting-ground. His idea was to erect the projected monument somewhere in the Teutoburg Forest, and when in 1837 he was wandering among the beautiful valleys of Lippe Land, he recognized the summit of the Grotenburg, near Detmold, 1,200 ft. high, as a suitable site for it. The exact place on which the carnage took place has never been definitely agreed upon, although scores of books have been written on the subject; but it is certain that the view from the Grotenburg peak, commanding as it does a beautiful prospect of the Teutoburger Forest, the Weser Mountains, the Brocken of the Hartz, the Rhenish Mountains, and the plains of Westphalia, undoubtedly includes the Varian battlefields. In 1838 Bandel's plans were received by his countrymen with warm enthusiasm. The project fully expressed the feelings of the Germans; for Hermann's memory, after 1,800 years, was still fresh, as was Barbarossa's in 1870 and 1871, and the undertaking was accepted as a national one. Societies for assisting in the erection of the monument sprang up in nearly all the cities of Germany, in Detmold, Hanover, Berlin, Paderborn, Münster, Lübeck, Bremen, Königsberg, Munich, Schwerin, Mayence, and Stuttgart. German newspapers supported the enterprise enthusiastically. Prince Leopold, of Lippe-Detmold, gave the required permission to erect a monument on the Teut, or Grotenburg, on the condition that it should be the grandest and worthiest in Germany. Contributions came steadily in; the German princes gave very handsome aid. The Prince of Lippe contributed a large sum, King Ludwig of Bavaria a thousand guldens, the King of Prussia promised his earnest support, and aid was cheerfully rendered by Germans in all countries in the world. Even the Germans of the Baltic provinces subscribed largely, after the Czar had given some two hundred pounds to the fund. A good sum was realized from poems and pictures, and in 1843 the sum of 34,421 thalers had been collected.

In the meantime Von Bandel had not been idle. On the 9th of July, 1838, the labour of felling and clearing away the trees from the summit of the mountain was commenced, and in October of the same year the foundation was laid, amid a fearful thunderstorm. The work was very arduous, and for the building of the substructure thirty-three stone-hewers, six masons, six stone-breakers, twenty-eight day labourers, and one smith, besides a number of peasants, were required. In the following spring Bandel was confronted by a pamphlet issued by the Detmold Society, in which not only were his previous labours criticised and censured, but it was proposed to supplant his design by the adoption of a statue on a model by Rauch and Schinkel, of Berlin; but this difficulty was removed by the Crown Prince of Prussia declaring in favour of Bandel's designs. Late in 1841 the vaulting of the foundation was completed. The edifice was then 34 ft. high. On the 17th June, 1846, the last stone of the substructure was placed in position, and the first portion of the great work was finished, the structure having now risen 93 ft. above the summit of the mountain. Then came trying times for the sculptor and for Germany; Hermann and Von Bandel were forgotten during the revolutions. Von Bandel took up his residence at Hanover, owing to further obstacles placed in the way by the Detmold Society, and there he again commenced to work for his existence; but as far as his means permitted him, he still persevered with the figure of his hero.

In 1860 new interest was awakened for the enterprise, and Von Bandel again visited the Grotenburg, journeying the whole distance on foot through the forest, amid pouring rain, expecting to find his little hut, where he hoped to shelter for the night. What was the old sculptor's grief, however, to find that his shelter had been torn down, by order of the Detmold Society! He sat down on a rock, and wept; but in the morning, when the sun rose brightly over the mountain tops, his faith in a brighter future was still unbounded. The funds had fallen short: the nation was again appealed to in 1862; and in the following year princes and people had contributed enough to enable the sculptor to proceed with the final preparations. Kaiser Wilhelm had given him two thousand thalers, and had honoured him with a visit to his workshop; and when 1870 came Bandel had beaten out every portion of the copper, mostly with his own hands, and this with only the small model to work by. On the occasion of the victory of Sedan the people of Detmold went as one man to the Grotenburg, and, in sight of the unfinished monument, celebrated the nation's triumph. This victory has been annually commemorated in the same place ever since.

In 1871 the Hanover Society petitioned the Reichstag for ten thousand thalers, and in May, 1872, that sum was voted for the completion of the monument, which would, said the Reichstag, have thenceforth a newer and a greater significance, commemorating not only the deeds of Hermann, but the unity of the German peoples. Owing to a rise in the prices of iron and copper, and also of labour, another petition was in 1874 handed to the Emperor, who appropriated nine thousand thalers more from the funds placed at his disposal in the Imperial treasury. Bandel had now prepared every part of the monument in Hanover, and the various portions having been transferred from the workshop to the Grotenburg, on the 23rd April the great iron cylinder, which serves as a support to the monument, weighing more than three tons, was hoisted into its position, after seventeen hours of hard work. On the 20th July the first portion of the figure was raised, piece by piece, and in October the task was prematurely suspended by the advent of winter. In the spring of 1875 Von Bandel once more returned to the mountain, and on the 1st May the great sword, weighing eleven cwt. and measuring 24 ft. in length, was let into the right fist. It was dangerous work, and caused the aged artist many a sleepless night. On the last-named morning the sun shone upon the gilded inscription of the sword—

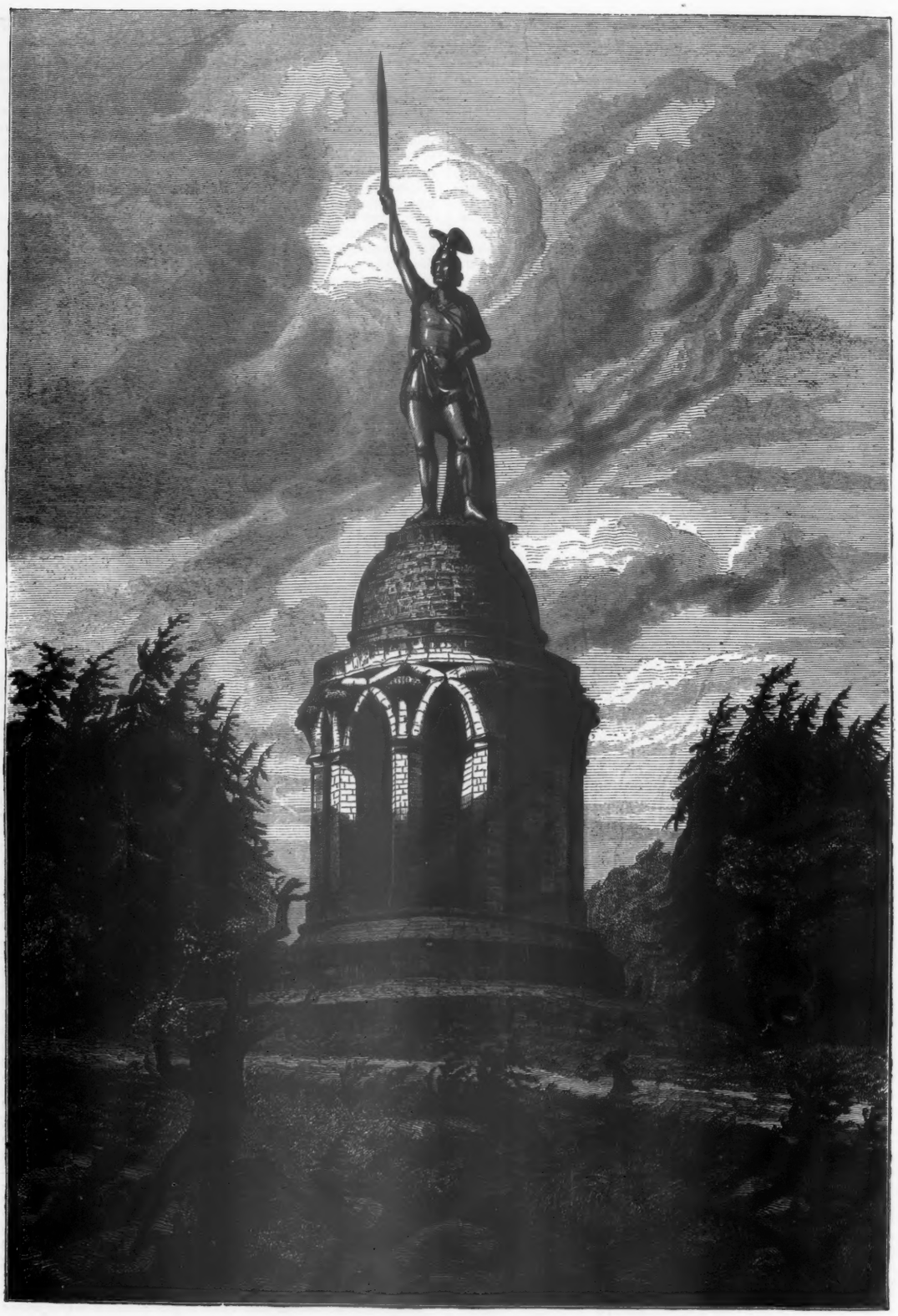
Deutsche Einigkeit meine Stärke:
Meine Stärke Deutschland's Macht!

German unity my strength:
My strength Germany's power!

On the 23rd of June the head and helmet were placed in their positions, and the last portions raised were the Roman eagle and the bundle of fasces, upon which rests the hero's left foot. Then the wooden scaffolding was removed, and the great work was accomplished. It was begun on the 9th July, 1838, and completed on the 23rd of June, 1875, after thirty-seven years. The cost of the entire monument has been about 90,000 thalers, or £13,000.

We will conclude this sketch with a few details relating to the monument itself. The substructure itself is visible for many miles to the wanderer in the Teutoburger Wald. It was important that it should be higher than the trees surrounding the summit of the Grotenburg, otherwise the figure of Hermann would not have been seen in its entirety. Corresponding to the rounded summit of the mountain a circle, 70 ft. in diameter, was taken as the basis. On this rises, 60 ft. in diameter, the socle, which tapers to a diameter of 59 ft., and from which rise the ten pillars, each measuring 23 ft. in height, and which are joined together by pointed arches. Above the vaulting is the basis of the dome, round which a gallery 4 ft. in width extends, upon which three hundred persons can find room. The basis of the cupola is about 39 ft. in diameter, and the crowning stone brings the entire substructure to the height of 93 ft. From the east side of the monument eight steps lead to the interior, and sixty-nine others ascend to the gallery, from which twenty-eight more lead to the hollow of the cupola and the anchorage. The entire substructure is built up of fifty-seven layers of hard sandstone.

In the niches of the substructure are various interesting and characteristic inscriptions and memorials. In one a relief of the Emperor William I., the model of which was made by Von Bandel in 1872, and cast from bronze cannon captured at Gravelotte, presented to Von Bandel by the Emperor himself. The head is in profile without ornamentation. Under the portrait is a copper-plate, inscribed in German with the following legend: "He united with a strong hand the long-separated people; he overcame victoriously the might and spite of France; he led home to the German Empire the sons who had been long lost; he is like Armin the deliverer." In the next niche is another inscription, reading as follows: "Only because the German people had become demoralised by French influence, and disunited, and thereby powerless, was Napoleon Buonaparte, Emperor of the French, enabled, with the help of Germans, to bring Germany under his yoke. But in 1813 all the German people gathered round the sword upheld by Prussia, in order to fight for freedom, and eradicate the disgrace which



THE ARMINIUS MONUMENT AT DETMOLD.

HEAD OF THE DETMOLD STATUE.

the Fatherland had seen." Underneath this are memorable dates of the War of Liberation.

The succeeding niche contains the well-known beautiful passage from Tacitus (Annal. II., 88): "Arminius liberator haud dubie Germaniæ, et qui non primordia populi Romani, sicut alii reges ducesque, sed florentissimum imperium, lacesserit: prœliis ambiguus, bello non victus." And finally another inscription: "On the 17th July, 1873, Louis Napoleon, France's Emperor, declared war against Prussia. Then arose all the nations of Germany, and from August 1870 until January 1871, ever victorious under the leadership of King William of Prussia (whom the German people called to be their Emperor on the 18th January), chastised the French frivolity and assumption." Chiselled in the structure are also the following words: "E. v. Bandel: July 9, 1838, June 17, 1846."

Upon the substructure, the plan of which will be clearly understood from the drawings given herewith, comes the figure of Hermann the Cheruscan. It measures to the point of the helmet 55 ft., to the elevated right hand 61 ft., and to the point of the sword 85 ft., the entire height of the monument thus being, reckoning the plate on which the figure rests, 183 ft. The dress of the hero consists of a kind of jerkin, trimmed with fur, and with short sleeves. The legs are covered with close-fitting braccæ, and the feet are encased in shoes trimmed with fur. A mantle, clasped round the shoulders, falls down the back, and upon the head is a winged helmet. The shield consists of five copper plates, and weighs twenty-three hundredweight. In its centre appears the simple word "Treufest" (true and firm), and encircling it is an ornamentation of winding ivy. The right hand holds aloft the ponderous sword, 24 ft. in length, with the inscription before given: on one side, "German Unity my Strength," on the other, "My Strength Germany's Power." The single parts of the figure are beaten plates of copper connected by soldering and screws. The sword was made first, then the head, with the neck and helmet, the right arm and left hand, the shield, the feet, the Roman eagle, and the fasces, upon which latter the left foot treads. The copper portions were made by Von Bandel himself, or under his immediate supervision; he worked with hammer and tongs, with fire, and with all his strength.

For the proper securing of his monument Bandel took as his model the growth of the fir-tree, which sends its roots deep into the earth, and extends them in an equal degree on all sides. Thus the figure of Hermann is fastened 13 ft. deep from the soles of the feet, in the middle of the structure, on a base 10 ft. in breadth, from which the eight anchors sink 28 ft. deep into the structure, where they secure the figure against the wrath of the violent storms that frequently rage in the Teutoburger Wald. For the support of the colossal figure, Bandel adopted—for the first time, we believe, for similar structures—the cylinder system, which, according to the opinion expressed by the Hanoverian Society of Architects and Engineers, gives greater stability than other systems; and with the Bandel anchorage the monument is able to withstand the force of a storm fifty- or sixty-fold greater than will ever be experienced on the Grotenburg.

The construction of the cylinder supports is as follows:—In the hollow of the cupola is an iron cylinder, made of half-inch plate, 13 ft. high, having a diameter of 10 ft., and which is firmly secured at its base and at the top, and by eight anchors at the foot of the cylinder. A smaller cylinder, securely fastened to the larger one by vertical walls, reaches to the foot of the figure. The metal plate on which the figure stands is fastened in the substructure by means of sixteen anchors, of 42 and 62 ft. in length. The anchorage scaffolding rises in three stories; the first, 24 ft. 6 in. high, consists of three cylinders, which bear a horizontal plate 14 ft. long and 6 ft. broad, having the form of the space within the hips of the figure. The principal cylinder, 5 ft. in diameter, stands in the shield and garment of the figure, and beside it, in the legs, are cylinders 2 ft. thick. The principal upholding cylinder weighs 67½ cwts., the one in the right leg 33 cwts., and the one in the left 24 cwts. These three cylinders are firmly connected together by means of a strong iron plate. In the second story, 10 ft. 5 in. high, are three cylinders, two of 3 ft. each in diameter, and one of 2 ft., reaching to the breast, where they support a plate 13 ft. long and 7 ft. broad, which fits the cavity. In the third story are two cylinders, one 15 ft. high and 3 ft. broad, standing over the central cylinder of the second story, and reaching to the head; the other, 4 ft. in diameter, tapering to 18 in., and 27 ft. long, supported on the right cylinder of the second story, and reaching to the hand, and connected in two places with the large cylinder leading to the head. The two "breast" cylinders weigh each 1 ton; that of the head is 15 cwts. From the top of the "head" cylinder proceed other supports for the wings of the helmet. The arm cylinder reaches to the hand. From this point downwards extends a holder of ⅝-in. plate, on which rests the iron rail supporting the sword. This rail, made of cast steel, weighs 5 cwts., and was presented to Bandel by Krupp; it is two-thirds of the length of the sword. The ribs of the iron scaffolding within the shield weigh 3,600 lbs. The figure is made up of 200 plates of copper, not counting the corner pieces, and the copper itself weighs nearly 9 tons.

The monument symbolises a principle—the greatness and the unity of Germany. It is a grand, commanding work. Armin is pronouncing, one would imagine, the solemn words of an oath which is repeated after him by thousands of devoted followers, whose souls thirst for the fray which shall bring them liberty, and for ever put an end to the Roman thraldom. At the foot of the design is the motto, the patriotic effusion of the great sculptor—

Nur in brüderlicher Einigkeit
Lebt Deutschland's Macht und Herrlichkeit.

Only in fraternal unity
Lives Germany's might and glory.

The hero exhorts his countrymen to banish from their memories their past schisms, and to unite their strength and patriotism against their common foe—Varus the Roman and his cohorts. The fancy will here carry us back to the impressive scene in Kleist's "Hermannschlacht," where the bards intone their spirit-stirring invocation—

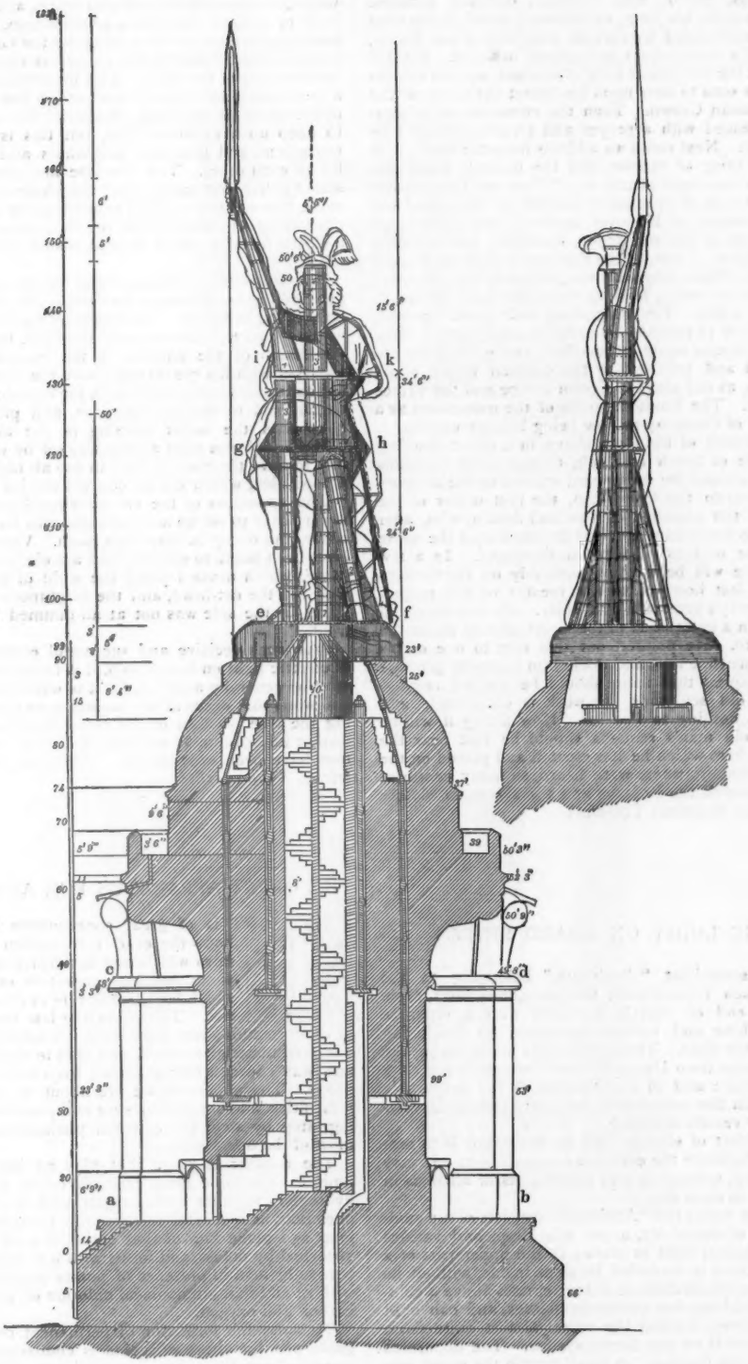
Child of the Gods! thou art so mild,
That springtime cannot milder shine;
To-day be terrible, be thunder-wild,
Till lightnings flush that face of thine!

Bandel has drawn a very good picture of his work, published by Brockhaus, of Leipsic, which not only portrays the monument, but also embodies an emblematical representation of the growth of the German people. Firmly rooted in the rock spring, from closely intertwined roots, the knotted and fast-adhering stems of the Teutonic tree, which, meeting from both sides in the form of an arch, enclose the whole picture as in a frame. The fragments of the rock, riven by the force of the swelling roots, lie scattered at the base of the double trunk, and on them are carved the names of the great battles fought by Germans, or in which Germans have ever taken a prominent part. The venerable artist himself writes upon this subject:—"The sentiment," he says, "that we, all who speak the German tongue, belong essentially and indissolubly to one another, is what I have endeavoured to express in the language of art through this picture. I have, therefore, recorded here the names of all the places where German blood has flowed in battle against a foreign yoke.

"The (alas! unavoidable) conflicts which our people were compelled to wage at home against their own kith and kin, have been intentionally omitted from this picture, dedicated to the power, the glory, and the greatness of Germany. Only those triumphs which Germany in her struggle for national life won from the foreigner, and the bloodless victories of the German intellect, shall be mentioned here. Accordingly, science, art, and religion, crown the national tree of Germany. May our people remain ever firmly knit together strongly armed and on the watch, a terror to the foe, who will not dare to assail us when he knows that he will find a united nation ready to give him blow for blow. Then Germania, our common mother, will have no need to rise from her seat in the rock, nor to draw her sword from its resting-place behind the shield of unity."

Von Bandel has not only spent the best years of his life, but has sacrificed a small fortune, in carrying out this noble work. Whenever he was engaged upon the work, he paid himself the same price as he paid his men, at first 3*s.*, and afterwards 4*s.* per day. Poor when he commenced the undertaking, he was poor when he had finished it, with only the satisfaction of having completed a grand work of art, of having consummated the one great ruling idea of his life. It is, however, pleasant to know that the Emperor has now granted him a pension of 4,000 marks per annum for the remainder of his life, and that his widow will receive half that amount until her death. In August of last year the inauguration of the monument took place on the Grotenburg, and it is gratifying that the venerable artist should have lived, not only to see the successful completion of his untiring labours, but to present his work to the Fatherland, amidst the rejoicings of thousands of his fellow-countrymen, and in the presence, and with the hearty and affectionate co-operation, of his Emperor.

Thirty thousand persons were present at the ceremony, including the Emperor William, the Crown Prince, Prince Carl of Prussia, the Prince and Princess of Lippe-Detmold, with their brilliant suites, and delegates from all the German monarchs,



SECTIONAL VIEW OF THE ARMINIUS MONUMENT.

and the monument was handed over to the German nation amid the roar of cannon and the enthusiastic cheering of the multitude. The long avenue facing the great structure was lined with tribunes occupied by ladies, and densely crowded with the societies, guilds, and students, carrying banners. Bandel, conspicuous by his long, white beard, stood at the door of his hut, and, surrounded by various members of his family, was the object of a spontaneous and general ovation. He advanced to receive the Emperor's congratulations, and on returning to his hut was seen to bear upon his breast the Cross of the Order of the Prussian Crown. Then the ceremony of inauguration was commenced with a prayer and sermon, followed by singing and music. Next came an address from the authorities of Detmold, and firing of cannon, and the military band stationed near the monument struck up "Ehre sei Gott in der Höhe," the thousands of spectators joining in the grand old chorale. Herr Lueders, of Hanover, spoke of the significance of the festival, and of the self-denial, sacrifices, and ultimate reward of the sculptor. Then, at the Emperor's bidding, Bandel ascended the royal tribune, where he was greeted by the Emperor, who grasped both his hands, holding them for some time. It was an affecting scene. The assembled multitudes cheered, while Bandel, unable to restrain his emotion, sank upon a chair and wept. The Emperor again approached, and holding the old man by the hand and pointing to the colossal figure, again congratulated him, as did also the Crown Prince and the Prince of Lippe-Detmold. The Emperor spoke of the monument as a beautiful one, and of Germany as now being happily united.

Thus, on the summit of the Grotenburg, in a forest clearing, beneath the shade of beech and oak, thousands of Germans were congregated around the monument erected to the memory and fame of Hermann the Cheruscan, the first uniter of the German tribes, in the presence of a second Armin, who, after more than eighteen hundred years, had accomplished the same end in uniting the nations of modern Germany. In a few years at most there will be another assembly on the Grotenburg, to pay the last honours to the creator of this mighty symbol of his country's greatness and unity. He has long ago chosen his grave, in a quiet nook of the forest, almost under the shadow of his hero. He pointed out this spot to one of his dearest friends some time ago, and made him solemnly promise to carry out the request that there should be his last resting-place. Yes! the old sculptor's life-work is completed, and henceforth he has nothing to live for. How fitting it will be that the glorious old man's remains should be laid near the image of the great hero which he has created and placed on the summit of the mountain, where were heard, so many centuries ago, the death-groans of the Romans and the shouts of victory of Hermann and his victorious Teutons!

ELECTRIC LIGHT ON BOARD SHIPS.

THE steamboat "Amérique," belonging to the French Transatlantic Company, has been, since the end of March, provided with a Gramme machine and various apparatus for producing electric light. The experiments made during the voyages from Havre to New York and back were completely successful; and in consequence of the favourable report of the captain the company immediately ordered similar apparatus for other vessels of theirs.

The principal object of electric light in navigation is to prevent collision and facilitate the entrance into harbours. It may also allow of loading, unloading, and movements of all sorts in the dark as well as in open day.

The apparatus on board the "Amérique" consists of a signal-light, a generator of electricity, a portable lamp, and various accessories. The signal light is placed in the upper part of a sheet-iron turret, which is ascended by steps inside, without its being necessary to cross on deck, as the turret rises above a companion. The signal-lamp has prismatic glasses, and can light an arc of 225 degrees, leaving the vessel almost quite dark. The electric regulator is on the Serrin system. The apparatus is suspended from the Cardan. A small seat in the upper part of the turret allows a superintendent to regulate the lamp on the spot.

The Gramme magneto-electric machine has a power of 200 Carrel jets. Its weight is nearly 4 cwt., and it is worked by a motor with three cylinders, on the Brotherhood system.

The speed is 850 turns a minute, both for the Gramme machine and its motor, the axes of the two being joined by a moving cylinder. The space occupied by the two does not exceed four feet long, two feet two inches broad, and two feet high. The cables which join the moving lamp to the generator of electricity are insulated. All the wires pass through the captain's cabin, who has communicators within reach, allowing him to stop the light in each of the lamps at discretion, one after the other or both together, and without stopping the Gramme machine. The novelty of the "Amérique" apparatus consists in the self-acting intermission of the light. This intermission is accomplished by a very simple mechanism fixed at the free extremity of the shaft of the Gramme machine. A special wire also allows the captain to keep up a constant light, but this is quite an exceptional movement, and generally brightness and darkness incessantly follow each other. The Gramme machine does not stop, as is stated above, but turns during the whole time the apparatus is at work, the electricity going sometimes to the lamp between two charcoal points from which the light springs, and sometimes to a closed metallic pencil of rays, which is alternately heated and cooled.

The Brotherhood motor, being placed on an unsteady surface, produced great vibration and noise, but this inconvenience will be avoided in future. The height of the lamp is 33 ft. above the water. The possible range of the light, taking into account the depression of the horizon, is ten geographical miles for an observer with his eye 20 feet above the water. In order to light up the topsails and gallant-sails, the captain had a truncated cone constructed of tinned sheet-iron, and placed on the movable lamp with the larger opening in the air. In this way the "Amérique" was seen a long way off by vessels when it suited him to have the electric light in use all night. This is certainly a good idea, which will be of great service in making land.

The apparatus of the Gramme machine does not cost much, is very easy to set up and manage, runs no risk of getting out of order, and occupies very little room. Various objections which have been made to electric light are obviated by the intermittent flame, which never injured the sight of any officer or man on watch at the cat-head, and the brightness of the green and red lights by the side was not at all dimmed by the signal-light in front.

After such decisive and successful experiments as to the use of electric light on board ship, it is to be hoped it will sooner or later be generally adopted, for it is well known that most of the collisions that occur at sea are owing to the difficulty of discerning the true position of the vessel close at hand. Meanwhile further improvements will get rid of some of the inconveniences that have been experienced. *Abridged from the Revue Industrielle, June* 14, 1876.

THE ORSAT APPARATUS FOR ANALYSING GASES.

IT is of great consequence to manufacturers to know the exact composition of the gaseous mixtures which may be formed in furnaces, blast furnaces, and gas-generators, or in the re-actions to which the manufacture of chemical products gives rise. Till within the last few years the analysis of these mixtures was considered laboratory work. It required a special material, science, and skill in chemical manipulations, and was consequently excluded from manufactories and workshops. The apparatus we are about to describe obviates all difficulties, and supplies a sure and practical method of following, step by step, the complex phenomena which accompany most of the operations.

The number of gases that play an important part is very limited. Carbonic acid, carbonic oxide, and the carburets of hydrogen, together with oxygen and nitrogen, are the only ones that, as a general rule, require consideration. Chemistry long ago made known that carbonic acid is capable of being absorbed by potass, and forms with it a definite compound, that pyrogallic acid in presence of potass absorbs oxygen by uniting with it, and that ammoniacal chloride of copper combines with carbon and oxygen.

To cause the formation of permanent combinations of these gases with the above re-agents is comparatively easy in a laboratory, where there are improved instruments and leisure at command. It is not so easy in factories, where an apparatus which is not cumbrous, simple manipulations, and experiments of very short duration, are indispensable. Under these circumstances the surfaces on which the contact of the gases and liquids takes place are necessarily very limited, and this imperfection, which appears insignificant, may completely vitiate the results.

The system of ingenious arrangements adopted by M. Orsat prevents this cause of error, and allows one in a few minutes to discern the proportions of the gases submitted to analysis with all needful exactness. We proceed to show how this may be done by means of the portable apparatus with three re-agents represented in our illustrations, figs. 1 and 2.

The gaseous mixture is drawn from the blast furnace, or gas-generator, by means of an iron or porcelain tube which enters the sides. If the average composition of the mixture is desired, a tube may be employed which has a very small crevice all along it—say about the fifth part of an inch. Beyond this tube may be placed a cooling cylinder to avoid burning the india-rubber conducting tube. The gas is thus conveyed to the tubulure P which is filled with carded cotton to stop the fumes.

To make the gas come, two courses may be adopted. The graduated tube A B and the flask D are connected together by an

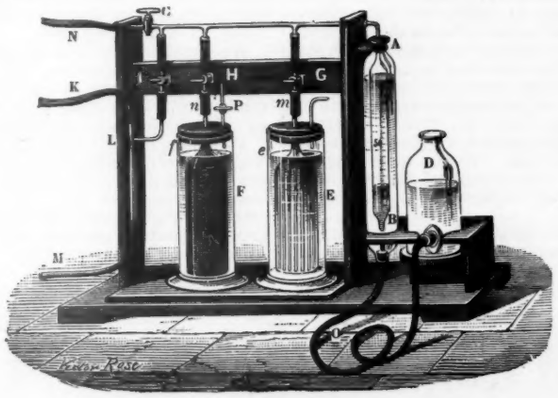


Fig. 1.

indiarubber tube, and thus form a system of communicating vessels. Consequently, if the flask D is raised or lowered, the graduated tube is filled or emptied. Suppose that all the taps in the apparatus are closed except the tap C, and the graduated tube is filled with water. By lowering the flask D we shall make the gas come through the conduit pipe N P. When the tube is once filled, by closing the tap C, opening the tap G, and raising the flask D, we shall drive out the gas originally introduced. This operation, which may be easily repeated, allows of quickly clearing the conduit pipe if it is not too long.

In the contrary case, recourse is had to the small pipe K L M, into which a current of water is poured. The tap C being closed, the clearing is effected by the tap R following the direction N P R L M.

This first point being settled, it is easy to see how, by merely opening the tap C and keeping the others shut, a specified volume of gas is introduced into the graduated tube by simply lowering the flask D. Marks made on the tube show when to stop. It is needless to insist on the careful attention which this operation of filling requires, and which becomes easy by practice.

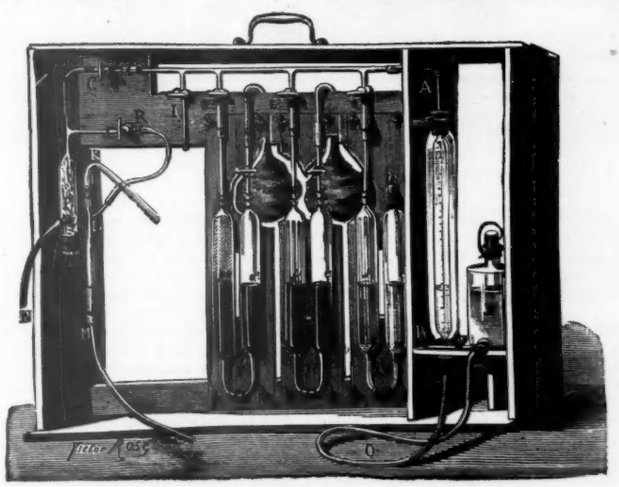


Fig. 2.

The tap C being closed, the volume of gas to be analysed is isolated.

The reactions are effected in the three U-shaped tubes, of which F contains a solution of potass, F′ a solution of pyrogallate of potass, and F″ ammoniacal chloride of copper. In order to multiply the surfaces present, which is a condition indispensable to accuracy in a rapid volumetric analysis, it is to be observed that in the branches f and f′ are inserted a number of small glass tubes open at both ends. When the gas penetrates through the taps G and G′, these tubes will keep a thin layer of liquid in adhesion, consequently the surfaces will be multiplied, and at the same time the conditions for absorption improved. In the branch f″, by introducing into the ammoniacal solution of hydro-chlorate of ammoniac a roll of metallic copper cloth, ammoniacal chloride of copper will be produced under the action of the oxygen of the air, and the surface of contact is increased by the cloth, which here acts a part similar to that of endless tubes.

As the solutions of pyrogallate and chloride of copper are altered in the air, the branches e′ and e″ end in india-rubber balloons filled with air, the oxygen of which is absorbed, so that there soon remains nothing more than nitrogen. Moreover, when the solution of chloride of copper becomes inactive, its activity may be restored by exposing it to contact with air.

After these explanations it is easy to understand the mode of operation. Into the meter A B 100 cubic centimetres (about 6 cubic inches) of gaseous mixture, measured between two marks, have been introduced. It will be admitted that the volume of the whole of the capillary tubes may be neglected. The taps being all closed, the tap G is opened, and on raising the flask D the mixture is made to pass into the tube F, where the carbonic acid is absorbed.

On lowering the flask D, the gas is brought into the meter. Care is taken to bring the liquid from the tube *f* to the mark traced on the edge, and to prevent its getting into the capillary tubes. The tap G is closed, and by managing so that the level of the water may be the same in the meter as in the flask D, the number of divisions gained by the water may be read, and consequently the number of cubic centimetres of carbonic acid contained in the mixture. The same operations are repeated in succession with the two tubes F′ and F″, care being taken after each operation to bring the gas into the graduated tube, and read the result as in the first case. At last there remains nothing but nitrogen. Hence the centesimal analysis of a mixture of carbonic acid, carbonic oxide, oxygen, and nitrogen is immediately obtained.

The arrangements we have described have been contrived in such a way that the instrument might be portable and occupy as little space as possible. Should it be set up for a permanency, as in case of observations carried on for the purpose of observing the working of a blast furnace or gas-generator, it will be better to use the apparatus represented in our last illustration (fig. 3). The principle is the same, but the dimensions of the absorbing vessels have been increased without inconvenience, which ensures almost absolute exactness in the analyses, and allows of making thousands of them without renewing the re-agents. The apparatus represented serves for analysing carbonic acid and carbonic oxide. It would be easy to complete it, and make it serve for analysing oxygen or any other of the gases mentioned above, as might be required.

Numerous trials of this apparatus in blast furnaces and steel works, and on locomotives, &c., have shown what advantages may be expected from its use in the study of the phenomena of combustion. We cannot show its utility more effectually than by citing the following instance.

M. Muller, formerly President of the French Society of Civil Engineers, employed in his factory at Ivry, where he makes fireproof productions, a gas-generator for heating the boiler of a steam engine. The admission of air could be regulated by means of a graduated register. The analysis of the mixture from the gas-generator gave carbonic acid 0 to 1 per cent., carbonic oxide 16 to 21 per cent. By a series of analyses of the

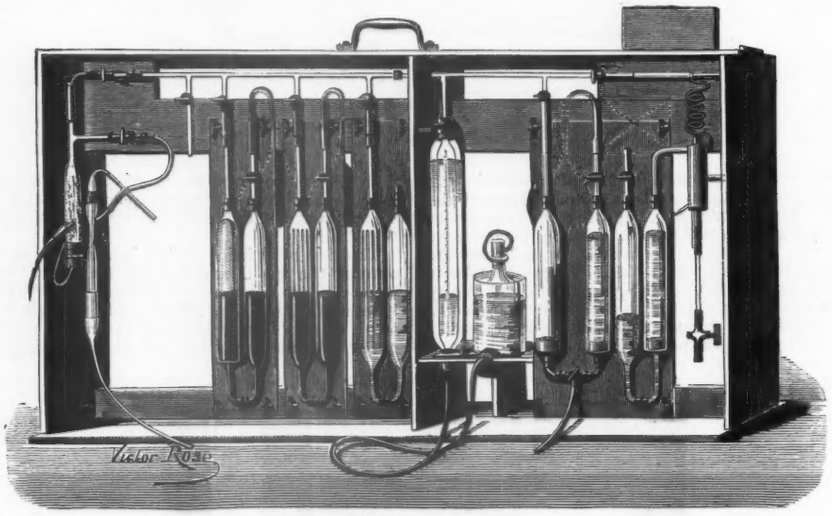


Fig. 3.

gases of combustion, and a suitable regulation of the register, the following result was regularly obtained :—Carbonic acid 15 to 19½ per cent., oxygen 0 to 4 per cent. The complete combustion of carbonic oxide without excess of air was effected by an average production of 9·04 kilogrammes (nearly 20 lbs.) of steam per kilogramme (2·2 lbs.).

M. Orsat has recently improved his Analyser, so that it is equally suited for analysing hydro-carburets. In spite of the apparent complication of the new arrangements, they are to be considered a decided advance, since hitherto purely scientific processes alone were available.

The principle consists in burning hydro-carburets in presence of a mixture of hydrogen and air, in a platinum capillary worm, heated red hot by means of a spirit lamp or gas jet.

The horizontal tube above is then prolonged to the right of the meter, and attached to a platinum worm which communicates with a U-shaped tube full of water. The pure hydrogen supplied by a U-shaped tube, one branch of which contains sulphuric acid and zinc, goes into the meter through a tube with a tap attached to the horizontal conduit pipe between the meter and the worm. Air is supplied by a tap placed beyond the entrance tap, to form a detonating mixture with the pure hydrogen.

We now proceed to explain the operation in taking an analysis of Siemens' furnace gas. Let us introduce 200 cubic centimetres (about 12 cubic inches) of a gaseous mixture, and first analyse the carbonic acid, carbonic oxide, and oxygen. We find the following proportions :—Carbonic acid 12, oxygen 0, carbonic oxide 43. There then remains nothing in the meter but nitrogen and the carburets. As the proportion of these latter is unknown, we will keep in the meter only 50 cubic centimetres (3 cubic inches), and put the remainder in reserve in the chloride of copper tube. Then 10 cubic centimetres (about ·6 of a cubic inch) of hydrogen are brought into the meter through the right tube, and 140 cubic centimetres (about 8·4 cubic inches) of air introduced to make up the 200 cubic centimetres (about 12 cubic inches) in volume.

We then send the new mixture into the platinum worm, repeating the movement with the flask. The carburets burn and change to carbonic acid and water at the same time as the auxiliary detonating mixture. On returning to the meter we find no more than 177 cubic centimetres (about 10¾ cubic inches) of a mixture of carbonic acid, oxygen, and nitrogen. The difference in volume of 23 cubic centimetres (about 1¼ cubic inch) is owing to the production of steam.

On the other hand the carbonic acid and free oxygen in the mixture can be analysed so as to leave nothing more than nitrogen. On deducting the proportion furnished by the air introduced, we easily get the volume of nitrogen in the original mixture, and by subtraction the volume of the hydro-carburets. The proportions of carbon and hydrogen are deduced from knowing the volumes of carbonic acid and steam.

The composition of the gaseous mixture alalysed is found to be :—

Carbonic acid	6
Carbonic oxide	21·5
Nitrogen	68·15
Hydro-carburets	4·35

The improvement just described does not present the same

simplicity and the same guarantees of exactness as the first part of the apparatus. M. Orsat does not hesitate to admit that in unskilful hands the chances of error may increase considerably, and even lead to comparatively serious mistakes. Nevertheless the Orsat Analyser is likely to render important services to the study and management of furnaces of every description, and particularly gas generators. It will furnish series of analyses capable of being compared together, and will render it possible to establish the theory of the phenomena of combustion in Siemens and Ponsard furnaces on well-ascertained results, and not on hypotheses more or less plausible. *Revue Industrielle, May* 3, 1876.

THE STORAGE OF PETROLEUM, BENZINE, OR SIMILAR FLUIDS, WHILE ON DRAUGHT FOR USE OR SALE.

THE class of substances here mentioned have now become articles of common and necessary use in manufactories, and regular branches of traffic in the shops; and many accidents, with sometimes serious disaster, result from their unexpected ignition and explosion. The great danger, of course, lies in the explosive mixture of air and hydro-carbon vapour, which forms in the partially empty tanks, barrels, or containing vessels, which occasionally ignites, notwithstanding the great care that may have been exercised to prevent any access of flame to the mixture. Wherever these fluids are kept it is usual to establish strict rules about drawing them off at night, and against the proximity of any light at any time. But when it is considered that a current or stream of the mixed vapour and air will convey a spark more rapidly than a train of gunpowder, it is not to be wondered at that every few days add to the record of coal oil explosions. Having become cognizant of the repeated explosions of a benzine storage tank at a gas-works—from flame twenty-five feet away—from a labourer's pipe entering the shed, from a plumber's furnace at a long distance, the writer advised the adoption of a plan which would effectually prevent all future accidents of this nature. As the same plan is applicable to all tanks or vessels for storage of these fluids, the present publication is made to bring it into notice. In the case of the gas works, all that was necessary to be done was to close the top of the tank gas-tight, and connect a pipe from the top to the gas mains.

Where the tank is to be supplied or refilled by means of a pump it is only needful to connect the supply pipe to it by a tight joint, but if the oil or benzine is poured in, a syphoned or sealed mouth or tube must be attached to the tank, so that it can be filled with, of course, the extra resistances of—in this case 3 in. of water pressure, and equally of course, upon drawing out any benzine, it would be discharged under 3 in. greater head than the height of benzine above the faucet. The result of the arrangement was to fill the space above the benzine with common gas, which may be inflammable enough to burn in air, but which is wholly inexplosive. In manufactories or shops which are lighted by gas the same arrangement is feasible, and it is only necessary to connect the top of the closed oil or benzine to the gas pipes of the building. Where dry meters are used for measuring the supply of gas they will register backwards the few feet of gas displaced by a fresh supply of oil or benzine, and most wet meters will also act in the same way. For some constructions of wet meters it would be best to lead a discharge gas pipe from top of this tank, and waste the contents of gas, when a fresh supply of benzine is received. Another method is to attach the faucet to the top of the tank or barrel, and connect the water pipe to the bottom, thus putting the contents of the barrel under the pressure of the water service, and preventing any influx of air, and precluding the existence of any vapour above the oil or benzine. And this arrangement can be modified by a separate vessel of water, in place of the water service of the city or town. For general convenience of application, and especially upon a large scale, where several barrels are to be stored, the gas connection is the most available, and the adoption of this method of preventing accident by manufactories and shops would be a real protection for property and life.

The storing of benzine under an atmosphere of gas is open to an objection arising from the absorption of a small quantity of gas by the benzine itself. The only real trouble which will follow will be the emission, for a short time, of a gaseous odour when the benzine is used; so far as the gas itself is concerned, it will be much improved in its illuminating powers by the absorption of a small proportion of vapour of benzine.

ON TURBINE WHEELS.[1]

By Emile Geyelin.

BEFORE defining the meaning of the word *turbine* allow me to say that water, the element made use of, having a given weight 62½ lbs. per cubic foot, becomes a source of power when that weight, owing to the topographical formation of the country, can reach a lower level; and that power is proportionate to the quantity of water in a given time, as well as to the height it is allowed to fall, power being the product of weight multiplied by velocity.

The means by which water is made to impart power are, as you all know, water wheels (and I might add water engines), of which undershot, breast, and overshot wheels form one class, and turbines form another; the distinguishing features of these wheels being, that whereas, in the first class, the water is allowed to act more by its weight, in the turbine class it is allowed to act more by the speed due to the fall under which it operates. The term "turbine" is derived from the Latin *turbo, turbinis*, a whirl or top. It would imply, and in fact I have seen it often stated, that it means water wheels turning on vertical axes; but it is not necessarily so, since they are, especially when brought to use under high falls, coupled together on a horizontal shaft, and in that position produce satisfactory results; in which case, the water being admitted in opposite directions neutralizes the great pressure that would otherwise be exerted on the step.

A review of the development of the turbine is a most interesting one; but we do not find any gigantic strides, such as the introduction of the railroad and the telegraph has made in the first half of this century. Still we can admire the final results, and see that through the patient labour of years, step by step, man has learned to avail himself of nearly the whole of nature's power in water, and with such certainty too that the greatly accumulated force can be relied upon with the same confidence as the daily rising of the sun.

Thousands upon thousands of our fellow beings derive a livelihood through its agency, and its effect upon the wealth of a people can be read in the plainest of language by looking at New England to-day. Holyoke, Lowell, Lawrence, Manchester—those young giants whose wealth is wholly created by water power, as developed by turbines—are but a fraction of what New England has already accumulated from its vast resources. Large amounts lie yet dormant in her streams, to be called into usefulness by her future engineers and capitalists.

Let us now follow the gradual development of the water wheel; at best we can but slightly touch a subject on which volumes may be profitably written.

Flutter and Undershot Wheels.

The most primitive structure to be found in the backwoods, far from any human centres—the Flutter wheel—seems like the first seed. Water may be plenty, but the means are scant. The noise of the water as it splashes on the rudely-shaped buckets will attract you towards it. Most likely, in a picturesque spot, you will find it, perched on moss-grown rocks, a slender axle holding a frame, to which are secured a few plates. No formulæ, laden with sines, cosines, cube root, or algebra, have given direction to its simple form. Shall we value it less? Let the tourist say, who, in the fragrant atmosphere of its surrounding pine and hemlock, has watched its unskilled efforts to shape a few boards. Near akin to the flutter wheel we have the Undershot wheel, more pretentious in its fitting apron, whereby less gamboling of the water is allowed as it comes dashing along. Look at the straight plates! Note how the water strikes them unprepared, to be left free a few moments later to continue its downward course! Are you surprised when told that one-third of the *vis viva* is all that these wheels develop? At this step science lends its help. First note how it bends the bucket into flat surfaces at varying obtuse angles; then the graceful curve of the Poncelet wheel. Here are no sudden shocks; the plates quietly receive the pressure, and, like a kind friend, hold the water in their folds to the very last. As a consequence, as high as sixty per cent. of force of the water has been developed by these wheels. The undershot wheels are adapted to low falls, and specially where slow motion is required, such as for the purpose of forcing air or water; but even in these conditions the turbines gradually take their places.

Overshot and Breast Wheels.

Many, no doubt, can remember when no other kind of water

[1] Read before the Franklin Institute, March 5, 1876.

wheels would have found approval; and this day, for a small varying stream, what can give better returns than the slow, patient overshot wheel, waiting for the water as it comes filling bucket after bucket, and turning round when ready with its well filled side? It is not in this puny capacity, however, that the merits of the overshot and breast wheel should be estimated. Years ago many a stately factory was propelled by them; but valuable as they are in their application to the falls varying from twelve to sixty feet, they have objectionable features which their rival, the turbine, has not; they are therefore fast losing ground.

Let us examine these objections. We have, for instance, the comparatively large size, especially where a large power is required in a concentrated form, such as the propelling of a large cotton or woollen mill. Again, the fact that for the most cases wood is employed in their construction, renders them short-lived and liable to many stoppages and repairs; we have also the necessity of having them housed in winter to prevent the ice from forming on their buckets; and last, but not least, we have as an objection the loss of power by friction, created by the changing of their slow motion to the high one of the main shaft, which in most mills amounts to an increase from ten to twenty fold. All these objections are common to both the breast and overshot wheels, but the breast wheel presents comparative advantages over the overshot, which render the preference for the turbine over the former less marked.

Take, for instance, a stream wherein the water level varies; the breast wheel, with the arrangement of gate, can adapt itself more readily than the overshot wheel. When the upper level falls, say, eighteen inches, it draws from the lower gate; whereas the overshot wheel, unless originally constructed with a pressure greater than necessary in the ordinary stages of the stream, will not be able to receive as much water as needed, owing to the reduced pressure over the gate. Another advantage of the breast wheel is, that the water, as it leaves the wheel, is forced away, whereas the water, as it leaves the overshot wheel, is, to some extent, drawn under, thus submerging the buckets to some extent. In the overshot wheel, also, much of the water leaves the wheel before the lower level is reached, and therefore its developed duty is proportionably lessened.

Though overshot and breast wheels are not to receive our special attention on this occasion, I have dwelt somewhat at length on their main features, so as to be better prepared to review the second class of water wheels, namely:

TURBINES.

How long water wheels revolving on vertical axes, or, to speak more properly, water wheels depending more on velocity than on gravity, have been in use, I am unable to say; it is quite certain, however, that fair specimens were left in Spain by the same people who left the Alhambra and other architectural wonders. Coming to more recent times, Belidor, the famous hydraulic engineer, a century and a half ago, in describing the fountains of Marly, amongst other kindred subjects, gives us descriptions and plans of water wheels belonging to this class.

Until the beginning of the present century the record of advance made in the construction of turbines is not worth stating; but the earlier years of the nineteenth century exhibit the fruit of patient labour, as shown in the Fourneyron turbine. This turbine was improved, both in detail and in efficiency, by two of New England's honoured sons, Uriah H. Boyden and James B. Francis, the former of whom may be considered its introducer into the mills of the United States. The perfection of their work rendered possible the great accumulation of power, whereby so many human hives are enabled to labour with profit to themselves, and to change the rocky hills into green and enlightened homes.

To state that the Fourneyron turbine was the only one of any merit, even a quarter of a century ago, would not be correct, since formidable rivals, especially those offering the advantage of smaller cost, soon made their appearance; and year by year since these new, or fancied new, applications of the water turned up, until now the turbine family is so large that its very names become bewildering.

In a theoretical point of view matters become much more simple, since many of the turbine wheels known to the public are but combinations, and sometimes simply poor imitations, of the parent stock.

For the purpose merely of tracing the analogy of the different kinds of turbines I should like you to note that in the simplest form, a jet, and in more perfect forms, a series of jets, gradually prepare the water to strike the plates of the revolving wheel. It is in the perfection of the direction of these jets, and the corresponding area of a section of them to the area of the openings for discharge in the revolving wheel, that the main advantage of a turbine lies. The better class of turbines embody the principle of reaction, whereby an additional force is obtained.

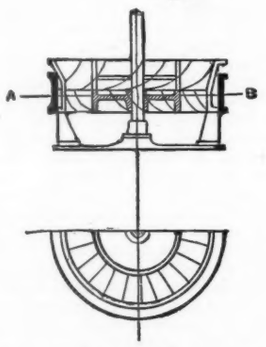
The Scroll, Reynolds, Trips, and Parker wheels illustrate the principle of a single jet. The water is led to the wheel through a contracted channel, and by increased velocity strikes the plates of the revolving wheel. The Scroll, Reynolds, and Trips, by the eccentric form of the casing, are able to act on the greater part of the periphery. The additional velocity to reach the extreme points created by the contraction of the inlet must always be obtained at the sacrifice of power, since the maximum effect of the water can only be obtained when the full pressure due to the fall is brought into action at the first point of contact with the wheel, which must be so constructed and speeded that the water will leave the wheel with the minimum of velocity. The wheels above named cannot thus lay claim to high duty, from the simplicity of their construction; and especially where great economy of water is not necessary they are much used. They are the pioneers to prepare the way for a more economical class of wheels to take their places.

Before speaking of the wheels where a series of jets is used in connection with the re-action principle, I would call your attention to the wheel acting solely on the re-action principle. In its primitive form it is known as Barker's wheel: a hollow, upright tube, through which the water is led to two arms near the extremities, and on the sides of each arm are openings for the escape of the water. This simple construction comprises all the component parts of a Barker's wheel. A better form of this wheel, made with a closer application of hydraulic laws, becomes the "Scotch motor," in which the water is brought in an ample tube to two gradually diminishing and gracefully curved arms, whereby the water is allowed to retain much of the pressure due to the difference of level under which it operates, and thus produce results which render it a most desirable motor, particularly where a constant changing of power is desired. The most successful application of that class of motors is at the Morris Canal, where they are used to propel the winding apparatus whereby canal boats are raised and lowered. Their construction is so plain that they proved most durable under quite unfavourable circumstances.

This reaction or retrograde force is thus the additional force whereby the highest returns of the water have been obtained. The first one to apply the double sources of power, impact and re-action, was Fourneyron.

The turbine represented on the screen (fig. 1) is an exact copy

Fig. 1

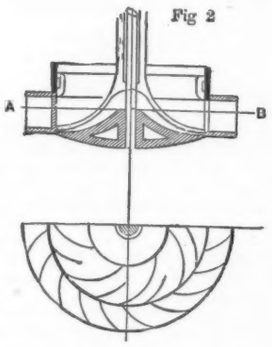


of one built by Fourneyron himself forty years ago. Were I able to give you on the same screen the same class of turbines as constructed by Boyden and Francis, you could not avoid admiration for the thoroughness of their researches in finding, applying, and perfecting curves, and for the mechanical appliances whereby the water is divided and prepared, from which curves and appliances were derived those astounding results (92 per cent.) of the total efficiency of the water power, that is, of what power it would require to replace the water used in propulsion back again in the basin. Notice the avoidance of sudden change of direction of the water, which, you will observe, is brought in a spacious conduit, whereby no great velocity is created: standard velocity being from 2 to 3 ft. per minute, nearly all is saved for the time of action on the wheel. From the base it is led by well formed cylindrical curves, secured on a stationary disk to the plates of the movable wheel. The angle at which the water leaves the guide plates is calculated to strike the plates as near the tangent as possible. The angle is in the best wheels from 14° to 15° to the tangent, which becomes the angle on which the force is applied. By a gradual contraction of the space between

the plates of the revolving wheel the water is brought to the point of discharge, which is so arranged as to direct its retrograding force so as to bring the resultant force at a still more reduced angle to the tangent. Careful computations make the ratio of forces as 8 is to 2.

In the year 1840 Jonval gave a new turbine to the world (fig. 2), which embodied a novel feature, in France at least, where it was invented, namely, the application of the vacuum. But a number of years previous, Zebulon Parker, in the State of Ohio, made practical applications of it in this country; he named

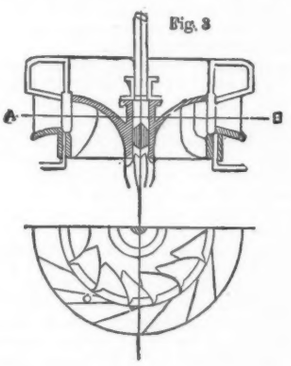
Fig 2



it the "draft tube." This draft tube is an air-tight casing, in which the water discharges after it has left the turbine; its lower extremity is submerged in the tail race water, thus excluding the air. The practical effect is, that a turbine provided with this draft tube can be placed between both levels that constitute the fall, and produce the same result as if the turbine were placed at the bottom of the fall. Where it is not desirable to make deep excavations, this application of draft tube becomes valuable. Before going any further I would state that all downward and inward discharge turbines, invented since, are making use of this feature.

The action of the water is somewhat different in the Jonval from what it is in the Fourneyron. A series of carefully prepared plates prepare the water for action by directing it from the per-

Fig. 3

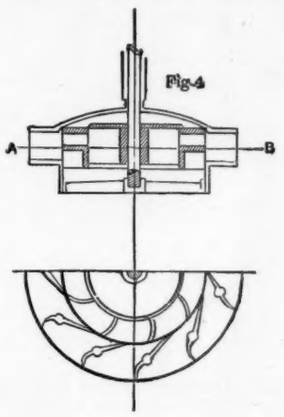


pendicular to an angle of 16° with the horizontal surface, when it is brought in contact with the plates of the revolving wheel, which plates are so placed as to receive the entering water as favourably as it is received by a Fourneyron wheel, but, instead of the water discharging outward, in the Jonval turbine it discharges downward. As usual with all downward discharge wheels, the Jonval has the merit of compactness, and this, in connection with the fact of being able to place it in any position between the two levels, makes it a very desirable hydraulic motor.

Let us now pass in review the remainder of the turbines most favourably known. 1. The charts represent the Swain, the Liffel (double), the Risdon, the American, and the Excelsior. All these wheels, either discharging inward or outward, make use of the double action of impact and reaction, and were they all constructed by the same mechanical engineer, very little difference would be found in the return of power from any given fall and quantity of water. The principal cause of loss of efficiency is to be found in the want of proper mechanical and engineering skill in adapting any particular wheel to the conditions under which it is to work, and specially so is the operation of gate or gates wherewith to open, close, or regulate the quantity of water to be used. For the purpose of facilitating the comparison I have shown the sections of wheels in cross lines, and of the gate in solid blast.

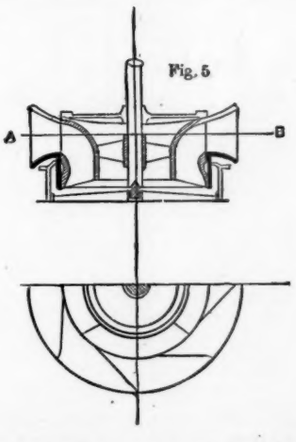
When performing an equal duty with an invariable supply of water, the gate of a turbine is used merely to start and stop. This condition, however, seldom occurs: either the resistance varies or the head or height of column of the water varies; and there are two modes of overcoming these variations. The first

Fig. 4



is, to have a series of turbines, sometimes of varying power, connected to a general shaft, and thus connect or detach a turbine as wanted. This plan is certainly good, but often, for want of space, or with the view to simplicity and compactness, it is desired to obtain the same results with one turbine. The second mode is that of closing or opening the gate or gates, and thus regulating the supply of water to meet the variation of head or the variation of resistance, or the effect of both variations combined. It stands to reason that the turbine which retains the two elements of power in their greatest perfection is the one that comes nearest to that desideratum of working the best results under

Fig. 5

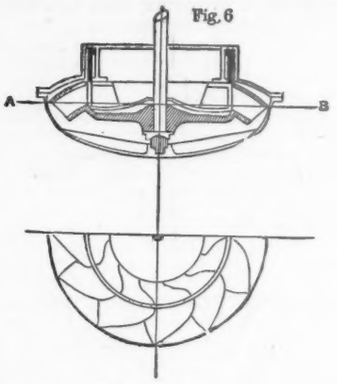


the above-named variations. The gate of the Fourneyron turbine, you will observe, is a ring closing between the guide and movable wheel. The effect of this gate on the stream of water must be bad, since it brings the water by an abrupt closure or stoppage into a flat, thin sheet, which, after passing beyond the gate, is left free to enlarge in thickness, on its way to the outer periphery, with not enough pressure left to act upon the wheel. Of course it would be possible for the makers of the Fourneyron turbine to construct the outer movable wheel in flat divisions, like a series of separate wheels, one upon another (in place of one wheel, as generally made), when each division of the wheel would only receive water as the gate is elevated; but this construction has not heretofore been used by them.

The Swain turbine (fig. 3), you will note, has a better gate

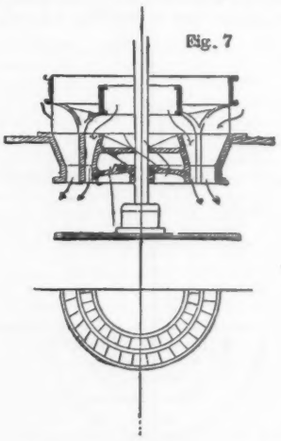
than the Fourneyron, since it brings the water between flat surfaces in any position it is put, but it is subject to the same objection as the Fourneyron gate, in not proportionally closing the movable wheel. The Liffel wheel (fig. 4) presents the same feature as the Swain, of directing the water between the flat though contracted passage ways to the point of action, but with it also a corresponding contraction is not established in the movable wheel. The same remarks may be applied to the American turbine (fig. 5), and the Excelsior (fig. 6).

Fig. 6



These conditions of imperfect action of the gate as usually applied to turbine wheels have led me to adopt a plan of gate for the Jonval turbine, which is here represented. It will be noticed (fig. 7) that the division of the water, in halves or in thirds, is complete, both in leading plates and in the movable wheel, and the streams do not meet until their duty on the turbine is performed. The water thus gives its proportionate pressure on the wheel as it enters it and as it leaves it. It is hardly necessary to say that careful experiments have proved the advantage of this plan of turbine. The gate of the ordinary Jonval is generally placed at the outlet, where it is free from any injury, and to perform the duty of starting and stopping the

Fig. 7



wheel no simpler and stronger arrangement could be desired; but for variable power or variable quantities of the water, the plan was a most unsuitable one, as it removed the point of contraction from the wheel altogether, and merely made a resistance to the flow of water beyond it.

I will close my remarks on turbines by alluding to one of the most interesting features of these water wheels—it is their practical application to any height of fall. I have seen the famous turbine of St. Blasien, made by Fourneyron, operating under 350 English feet fall, giving 73 horse power, which is so well known to readers on this subject of turbines; but as a parallel example to this one, I desire to record one made by me in 1854, for Saltillo, Mexico, which was a double turbine (that is, a turbine receiving water between two movable wheels on the same shaft, which counterbalanced each other, and avoided the necessity of resisting the thrust from the head of water,) for 160 ft. fall, producing 125 horse power, and turning at a speed of 1,850 revolutions per hour. This double turbine, though only 11 in. in diameter, propels a cotton mill of 10,000 spindles.

And now, gentlemen, to show what importance is attached to the practical applications of turbines, I have to say that the United States Centennial Exhibition has been engaged in preparing a most complete testing apparatus, where the world at large are invited to bring their wheels to be tested by a competent committee of mechanics. Let us hope that the results will establish the superiority of the turbines of the United States in the ensuing competition.

LOCOMOTIVES FOR TRAMWAYS.

RAILWAYS have now been in use long enough to show that they benefit not merely those who use them, but that the moderate cost of transit and the great saving of time and labour afford advantages to neighbouring districts. It has often been found that the opening of a railway has increased the value of property in the neighbourhood fifty per cent. A great part of a farmer's receipts, who is far from any railway, is swallowed up by the cost of conveying his produce and fetching from a distance his timber, implements, and various articles of necessity. All this expense is very much reduced as soon as a railway with its station is opened in the neighbourhood. If there were no direct saving, there would be indirectly, since the number of men and horses employed can be reduced, and thus the net proceeds of the property increased.

Generally, however, railways benefit places that are already richer than and superior to others through the development they have received. While railways increase the prosperity of a country, they require on the other hand a certain degree of development for their subsistence. It is true it is not necessary for a railway, regarded in a general point of view, to yield a direct profit for even if it occasions losses they may be largely compensated by the advantage to those who make use of it. It is not to be expected, however, that private companies should take account of this circumstance, and even in the case of state railways, the government would always hesitate to cause the treasury a direct loss, though the indirect advantages might preponderate. In places where considerations of this kind are opposed to the opening of a railway, as *e. g.* in Norway, lines of narrow gauge have been constructed which, on account of the lightness of the material employed and the moderate expense of working, require much less capital than ordinary lines.

Latterly attention has been directed to another means of transit which seems likely to prove a useful supplement to railways. M. A. Kohl, a Danish engineer, proposes the use of small locomotives on rails laid down along existing roads, and has produced a locomotive which appears very suitable for the purpose. His proposed scheme was discussed in the Rigsdag or Danish parliament on the 20th of February last year, and a law to the following effect was passed in reference to the use of locomotives on tramways :—

"The minister of the interior is authorized to grant permission for laying down in the streets and public roads rails for the service of locomotives which give out no smoke, and are in all other respects constructed in such a manner as not to impede general traffic, subject to the condition that the minister, after consulting the municipal authority, shall decide in each case as to the construction and working of the line. By the concession the exclusive right of using the line for a period of forty years will be granted. At the expiration of this period the commune of the town, bailiwick, or parish through which the tramway passes will be authorised to require the rails to be taken up and the road put in repair at the cost of the concessionary, or the line to be made over to it for a sum fixed by arbitrators duly appointed. The minister may, on the recommendation of the local authority, prolong the term fixed for the duration of the exclusive right. If disagreement arises between the communes through whose land the line passes as to how matters shall be arranged at the expiration of the fixed term, the minister shall decide after communicating with the parties concerned. Moreover, the minister of the interior may allow locomotives answering to the above description to be used instead of horses on the tramways."

In considering the advantages and defects of the proposed system, the first point to be decided is, whether locomotives can be constructed suitable for use on a tramway of light construction. Although locomotives of this kind have not been tried long, the experiments made at Copenhagen are sufficient to prove that the difficulties in the way have been overcome. A

KOHL'S LOCOMOTIVE FOR TRAMWAYS.

trial of M. Kohl's locomotive was made at Copenhagen, August 10, 1875, which the "Dags Telegrafen" of the following day thus described :—

"Yesterday morning, between six and eight o'clock, a trial was made of the locomotive for tramways constructed by M. Alexis Kohl, civil engineer. The trial took place on the road worked by the American Omnibus Company, in the presence of several persons specially invited and a jury of experts appointed by the Minister of the Interior. The locomotive was attached to an American omnibus, which was full, and after having performed several short runs backwards and forwards, it traversed the whole American omnibus line, drawing the omnibus one way and pushing it on the return journey. It went easily and without interruption through the streets of the north faubourg, which were crowded with vehicles and have sharp curves. Neither the foot-passengers nor the inhabitants in the neighbourhood experienced any inconvenience. The locomotive gave out no smoke, and, with the exception of a bell, which is necessary to warn persons on foot, no noise was heard. There was no sound of blast or whistle. Excepting in the case of a young horse, that was a little restive, none of the horses in the vehicles that passed were startled, so that as far as general traffic is concerned there seems no objection to the use of the locomotive in the streets of the city. As we have stated above, it went without difficulty along all the curves, both when drawing and pushing the omnibus, and stopped readily, which is a great advantage. On returning, the force of the steam was increased so as to make it go faster than a vehicle drawn by horses at full trot, yet at a given signal it stopped quite as quickly as such a vehicle. The consumption of combustible must be very small. The locomotive in its present form appears to satisfy all the conditions required for such a means of conveyance intended to pass through streets where there is great traffic. To those who have not made this question a special study it seems that this invention realises a useful and economical progress which is worthy of consideration."

Most of the other journals gave similarly favourable accounts, from which the following conclusions as to the locomotive may be drawn :—

1. It weighs only about five tons, which is the weight of an American omnibus completely full. Hence it will not be too heavy for the strength of an ordinary tramway.

2. It easily draws two American omnibuses completely full.

3. It passes along sharp curves with a radius of 35 ft., and ascends gradients of 1 in 20.

4. In external appearance it is like an ordinary American omnibus, but of course is much smaller. It gives out no smoke or steam, and does not make so much noise as an ordinary American omnibus.

5. It can at its highest speed be stopped as quickly as a vehicle going at an ordinary trotting pace.

These results show that it is possible to use locomotives on ordinary tramways. Only two points, therefore, remain to be considered: whether these tramways can be of advantage, and whether there will be any danger to travellers and passengers along the road.

As to the danger for travellers, it is certainly less than that to which they are exposed in an ordinary vehicle, the horses of which sometimes take fright. It is true the omnibuses may get off the line, but the speed will not be high enough to render that a serious evil. What is most to be feared is, that the sight of a locomotive may frighten the horses it meets on the way, and this fear induced several members of the Rigsdag to vote against the law. But it should be observed that the journals when reporting the above trial say, though the locomotive met in its course a great many horses, only one was a little restive, while all the others were quite unaffected by the sight of the train. There is consequently no great cause for alarm on this head, especially as in all probability the rails will be laid down in roads of considerable width.

As to the advantages of such tramways, they will naturally depend in a great measure on local circumstances. The speed can hardly be greater than 9 to 10 English miles an hour, but this is not of much importance for the working of a local line. What is more important is, that the trains, besides being frequent and regular, stop when passengers or parcels have to be taken up or set down. The chief question however is, whether the expenses of constructing and working such tramways will be small enough to allow of the fares being fixed so low as to prove advantageous to the neighbourhood. It is impossible to form even an approximate estimate of the receipts and expenses, since they must depend very much on local conditions. It may be expected that the total expense of construction and rolling stock will vary, according to circumstances, from £1,600 to £2,400 a mile. Considering this comparatively small amount, the very small consumption of coal, and the moderate speed, which will allow the locomotive to be stopped whenever it is desired, and not merely at fixed stations, it is evident that a line of this sort through populous parts is likely not only to yield a good profit to the proprietors, but also to contribute to the spread of wealth and civilization around.

It is to be observed that two systems have been usually adopted in the construction of locomotives for tramways, the engine being enclosed either in the travellers' carriage or in a separate one. The latter plan is evidently best, because it does not incommode the travellers, and, in case of any accident to the engine, horses can be used instead of the locomotive, so that they can be conveyed to their destination without much loss of time. This is the system which M. Kohl has adopted, as appears from our illustration.

MACHINE FOR FULLING FELT-COVERS IN HAT MANUFACTURE.

THE raw materials which serve for the manufacture of felt hats are the hair and wool of animals, and it is especially the wool that is so employed, because it possesses more than any other raw material the property of making good felt. The manufacture of felt hats has recently been greatly extended, and is now almost exclusively carried on by machinery, which has been much improved, so as to meet every requirement with regard to quality.

The hair of rabbits and hares is especially suitable for the manufacture of felt, but is used only for middling sorts, while for superfine goods a mixture of beaver and musk hair is used. For very coarse felt camel hair is still employed.

The greatest quantities of rabbit skins used in felt manufacture come from France and Belgium, the former supplying seventy to eighty millions, and the latter twelve to fifteen. England produces only a few of these skins, but brings into the market twenty-five to thirty millions of hareskins. Next to these countries come Russia, Switzerland, Norway, and Germany, with smaller quantities.

The preparation of the hair for felt manufacture embraces eight separate operations :—1. Moistening; 2. Slitting; 3. Removing the bristly hairs; 4. Mordanting and drying in large tubs; 5. Brushing; 6. Shearing; 7. Sorting according to quality; 8. Blowing. The dry skins are first moistened to render them soft, and then placed on two forks, on which the separate skins are slit up. After this the coarse hairs of the skin are removed to a separate place. This is one of the most difficult and troublesome operations, as only the coarse bristly hairs that stick up are seized and pulled out, in order that the fine woolly hairs may remain fastened to the skin. Machinery does not answer for these operations, which are consequently for the most part performed by hand. The mordanting is accomplished by brushing hard the hair side of the skin with brushes impregnated with a fluid consisting of diluted sulphuric acid and sublimate of mercury, which renders the hair adapted for manufacture into felt, but acts injuriously on the respiratory organs of the workmen. Unfortunately it has not yet been found possible to perform this operation by machinery. After the brushing, the hairs are dried in large tubs, and then all brushed in one direction to facilitate their removal from the skin. This is done by machinery. The skins are placed upon two slowly revolving rollers covered with wool, from which they pass to a swiftly turning cylinder furnished with brushes. They are thus completely freed from all adhering impurities. During all these operations the skins are continually kept in a more or less moist condition to facilitate their preparation, and render them better fitted for the cutting off of the hair.

This operation is performed by machinery. The skins are first cut into narrow strips of about half a millimetre (·02 in.) in breadth without being at all injured, after which, the cutting off of the hair takes place. The machine for this purpose consists of two small cylinders which bring the skin to knives. One of these is fixed, and the rest are mounted in spiral courses on a cylinder, like those in shearing machines which are used in the manufacture of cloth. After this operation the hairs are collected on zinc plates, and in exactly the same order as if they were still on the skin, and sorted by workwomen according to quality. They then come to the blowing machine, as it is called, which separates the hairs from each other, and purifies them. This machine consists of three parts: the apparatus for bringing the hair, the conduit pipe, and the chamber. The bringing apparatus consists of a simple pipe, which conveys the hair to two channelled cylinders, behind which is a ventilator

revolving with great rapidity so as to make 3,000 turns a minute. By the ventilator the hair is driven into a horizontal conduit pipe, at the end of which is a vertical pipe connected with a closed chamber, in which the separate hairs are dispersed and purified from the dust clinging to them, and fall down in the form of light flue. The distance of the point at which the hairs fall from the entrance is in inverse proportion to their compactness, and as the quality of the hairs is also in inverse proportion to their weight, a self-acting sorting is effected according to the various qualities. But in order that the several qualities may be clearly distinguished, this operation has to be repeated five or six times.

All the above operations are intended simply to prepare the raw material for manufacture, the separate processes of which are the following:—

1. *Condensing.*—The object of this operation is to collect the hair about a cone till at least a more or less thick, light, and woolly mass is formed. For this purpose the cone is furnished with a great number of small openings, and a ventilator is put inside it, which sucks in the hair spread out on the cone by a special mechanism. This mechanism, of American origin, has been lately improved by Messrs. Laville.

As soon as the cone is covered with a sufficiently thick layer of hair, a wet cloth is spread over it, and this is covered with a

Fig. 1.

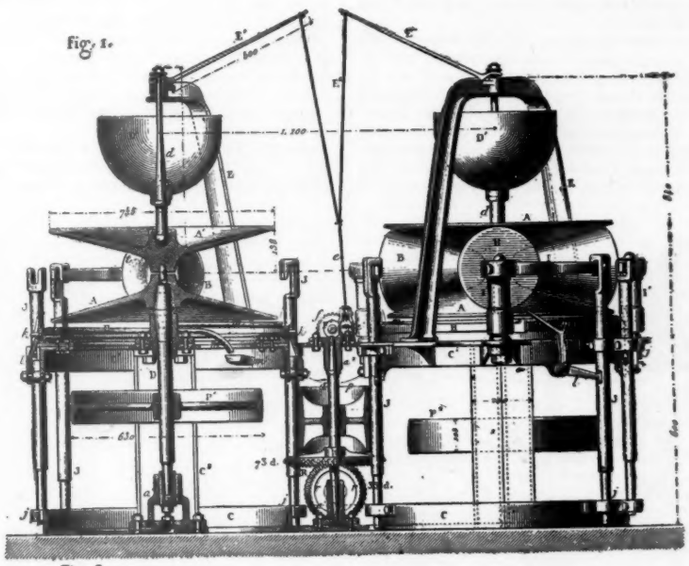
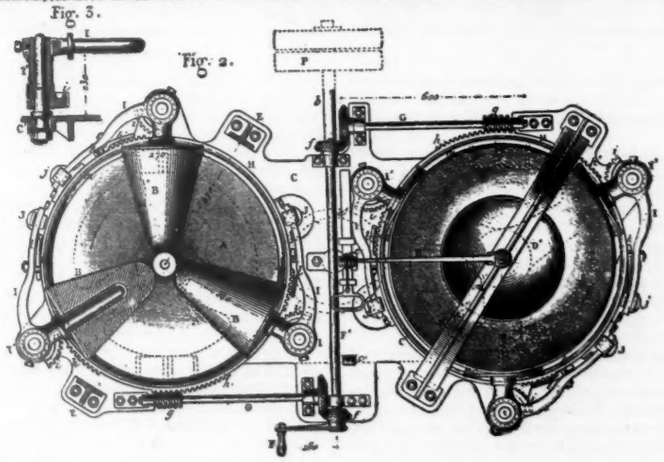


Fig. 3.

Fig. 2.



metal cover, with various large openings in it to bring the layers of hair into complete contact with the hot acid fluid in which the whole apparatus is dipped. In this way a small quantity of material converted to felt, possessing a certain consistence, is obtained, but not yet firm enough to undergo the further operations without being torn to pieces.

To give it the necessary firmness, it is well rubbed with the hands on a heated table between woollen cloths. It has been attempted to substitute the action of machinery for this hand-work, and we exhibit the vertical and two horizontal sections (figs. 1, 2, and 3) of a machine constructed for the purpose.

It will be seen at a glance that the fulling of the felt-layer is accomplished by two conical plates, A and A^1, the felt-layer being drawn upon the cones B B B. The machine consists of a lower cast-iron plate which is connected with the upper plate C^1 by vertical supports C^2. Between the four vertical connecting pillars C^2 is placed a vertical transmission shaft *a*, which at its lower bed is screwed tight on the lower plate, and at its upper one to the upper plate C^1. This vertical spindle receives its rotatory motion from a sheave-shaft, which is for this purpose furnished with the sheave P and the conical wheel *r*, which fits into the horizontal conical wheel R.

Above this conical wheel, the axle of which at its lower end runs in a bed screwed fast to the fundamental plate, a second pulley *p* is fastened, which is so broad that it can hold two straps, the left one of which moves the sheave P^1 and the right one the sheave P^2. On the upper end of the vertical shaft D, which has a double cone, the lower rolling plate A is so placed that by the turning of the former the latter is carried with it. The second conical plate A^1, on the contrary, which is placed on

the plate A in a reversed position, cannot be moved directly by the shaft D, because it must turn in a contrary direction. For this purpose it is placed with a central pivot on the lower conical plate A, but so loosely that it cannot be carried with it by friction. The plate A^1 consequently receives its motion through the friction of the small cones B B B, which are covered with felt and carried along with the lower plate A. This friction may be increased at discretion by loading the upper plate A^1. For this purpose the plate A is hung on to the shaft D with a ball-and-socket joint, and the shaft goes through an opening of the bearer E, and is supported at its upper end by the lever E^1. On the above-mentioned shaft D, above the conical plate A^1, a hemispherical vessel D is placed, which can be filled with lead, and in this way regulates the pressure of the plate A^1 on the cones covered with felt B B B.

In order to be able to raise the upper plate A^1 from the felt cones after the fulling is completed, a drawing rod, E^2, is attached to the end of the lever E, which at its lower end can be drawn down with a leather thong *e*, running over a pulley and fastened to a horizontal drawing rod E^1 (fig. 2). By this means the plate A^1 is raised. When this has been done, the felt cones B B B are easily removed by a simple contrivance. The cones, which are made of hard wood, are set upon horizontal pivots connected with the spindles I^1 (fig. 2), which, revolving in vertical collars, are at their lower end furnished with a bent arm I. The cones B B B can move freely about their pivots, while they are kept in their position by a toothed sector *i* which is at the lower end of the vertical spindle I^1, and the teeth of which catch those of a horizontal revolving rim H. The arms I are intended to steady the vertical spindles I^1 during the work, and for this purpose are held fast by vertical cramp irons, which can be put on and off, so that the pivots of the cones B are unmoved.

When the operations are completed, and the upper conical plate A^1 is removed, as well as the felt from the cones B B B, they are turned outwards by the toothed sectors at their spindles I^1 through the turning of the toothed screw H by means of the conical wheel apparatus *f f g g*. In order that this may be accomplished, the lever I must be released at the same time, and this is done by a simple bent lever (shown in fig. 1), which on the one hand fastens on to a pivot of the revolving rim H, and on the other to the slit in the vertical hook-support J. By this turning of the rim H the hook-supports J are turned at the same time as the spindles I^1, so that these, together with the pivots, their cones, and the lever I, can easily be turned out.

As the preceding operations require the constant presence of hot water to keep the felt damp during the rolling, the upper plate A^1 has eight openings A with a diameter of three millimetres (about a tenth of an inch), and the hot water poured upon the plate A^1 runs through them to the lower conical plate A into a channel *m*, from which it is conveyed by a discharge pipe into the channel m^1.

Fig. 4.

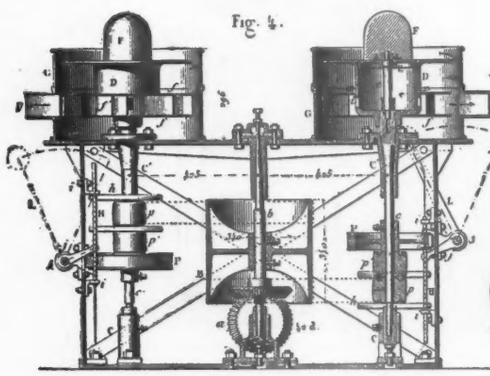


Fig. 7.

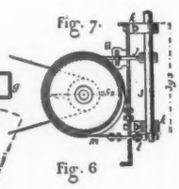
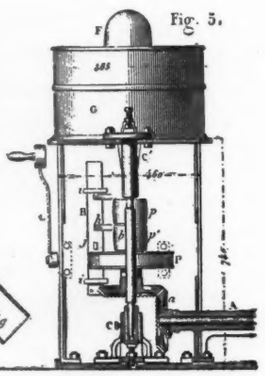


Fig. 6

Fig. 5.



When the machine is to be set to work, the wooden cones B B B are drawn out as mentioned above, and each of them supplied with at least enough felt for two felt-covers. Then by the contrary movement of the apparatus *f g* these cones are again brought back to their regular central position, and there held fast by the simultaneous lowering of the hook-bearer J. The upper rolling plate A^1 is then lowered on to the wooden cones, and the machine is set in motion. After the expiration of two or three minutes, according to the number of felt-covers laid on, the work is finished, and by reversed operations the felt-covers are removed from the cones.

The lower conical rolling plate A makes 50 turns a minute, and at this speed a workman can easily prepare ten dozen felt-covers an hour. The machine represented in our illustration was constructed and is used by Messrs. Klein & Co., at Liegnitz.

2. *Felting*.—On this operation depends in a great measure the quality of the articles produced, and in many factories it is still performed by hand, although several machines have been already constructed for this purpose. Among these we may mention Messrs. Laville's felt-machine with double rollers, which may be considered the only one capable of accomplishing even a partially favourable result.

When the felting is completed the preparatory operations are over, and the subsequent manipulations chiefly relate to the production of the varied hat-forms, shapes, or blocks, from the felt covers already made.

The felting has considerably diminished the dimensions of the product resulting from previous operations, and the chief object now is to give the separate covers a greater thickness at the edges, which are to form the brim of the hat, than in the middle. In 1867 an American machine for performing this operation without hand-work was sent to the Paris Exhibition. It consisted of various copper lever-systems, which were set in motion by a treadle, and gave shape to the felt cover. The border, taken by suitable tongs, was stretched out on the treadle repeatedly, according to the degree of pressure. In this way a block or shape was produced by one operation, and hence the idea on which the machine was founded certainly deserved commendation. It is, however, very unlikely that the machine could accomplish its object, and hence it is of no great importance to hat manufacture.

After the felt has acquired the necessary gradations of thickness it is dried in chambers, and then subjected to an operation for the purpose of removing the unevenness and roughness that may still remain, which is done by pumice-stone paper or emery paper. This work is still here and there done by hand, but can be well done by machine, and we exhibit representations of a smoothing machine which Messrs. Haust of Leignitz have constructed.

Fig. 4 is a vertical section, fig. 5 a view, figs. 6 and 7 are details of the construction. The machine is double, and, as in the fulling machine previously represented, two shapes can be smoothed by it at the same time. On a common frame are placed two spindles C C', which, being provided with two smaller sheaves and a larger one, are set in motion by an impelling shaft *b* between them, with a broad sheave B. The shaft *b* receives its movement, as is evident from fig. 5, by a horizontal shaft A, which has at its end a conical wheel *a* working in another conical wheel attached to the central spindle (figs. 4 and 5). The two working spindles terminate below in accurately centred beds, C, and above in conical sockets, so that a perfectly undisturbed central rotation may be secured. At their upper end, which is conically chamfered, these working spindles support a hollow vessel, D, which is only loosely attached, and is carried along by friction alone. This vessel has at its upper part a very broad rim, and in the middle a sheave which is firmly fixed on the upper end of a small spindle, *e*, which is itself at its lower end embedded in the working spindle C' (fig. 4). This sheave, E, is adjusted with great care, so that it moves perfectly centrally with the vessel D.

On the upper end of the small spindle *e*, which has a screw-thread, is a wooden cone, F, screwed on by means of a female

screw in it, so that the cone partakes in the turning of the spindle. To the vessel D a ventilator-wheel is attached, which moves simultaneously with it, formed of two plated metal sheaves and divided into separate radiating chambers by the vertical cross partitions *f*, as is seen in fig. 6.

The above-mentioned vessel D, together with the ventilator attached, is set in a larger socket, which consists of two cast-iron rings placed one above the other, the lower of which has an outlet *g* exactly in the plane of the ventilator. The dust arising from the smoothing of the felt with pumice-stone is carried with the strong current of air produced by the ventilator to the rim, *x*, of the vessel D and the ventilator, by which it is hurled to the discharge canal *g*, in which it is conveyed farther.

It is evident that the construction of this machine is simple, and its use may soon be learnt by the most unpractised workman. An important feature in the machine is the brake-apparatus, by which it is stopped very quickly and its capability for work increased: for it is not enough for the machine to be stopped suddenly, but the separate felt-covers must be quickly put on and taken off, which necessitates a speedy start as well as stoppage of the machine. To accomplish this important object, each spindle has a sheave *p* attached to it, and another moving freely *p'*, as well as a wheeled brake-sheave P. The first two sheaves serve for moving the spindle, and the free movement of the independent sheave as soon as the spindle is stopped by the brake-apparatus. The brake-sheave P has a brake-hoop, as shown in fig. 7 in ground-plan, which is fastened at one end to the frame of the machine and at the other to a small ex-centre formed by the eccentric pivot in the horizontal brake-shaft J. To the latter an arm *j* (fig. 4) is attached, which moves the guide-forks of the straps up and down as soon as the shaft J is moved by the lever L. In this way the strap is moved from the fastened sheave *p* on to the freely moving sheave *p'*, and on the other hand, at the same time, the brake-hoop pulled in, so that the working spindles can be stopped in a remarkably short time. On the starting of the machine a reversed movement takes place, the brake-hoop being locked, and the moving strap of the free sheaves is put on the fastened one.

The speed of the machine when in good working is 1,800 to 2,000 turns a minute, which is attained by adapting the dimensions of the main moving-sheaves to the sheave *p*, *p'*, and the speed of the main moving-shaft A, which makes sixty turns a minute. According to the shape of the hats to be smoothed by pumice-stone paper or emery paper, wooden forms, F, must be screwed on to the machine with a left worm, in order that it may not be stopped during its turning, which takes place to the right. Generally several hats are stuck on one form, and the brims rest on the rim of the vessel D. First the surfaces of the brims are smoothed, then the body of the hats. After the smoothing is over the shaft is kept revolving for some moments to get all the dust removed by the ventilator. The machine is then stopped, and the shapes are taken off, and being reversed the inner side is now smoothed. *Stummer's Ingenieur, May* 26, 1876.

Chemistry applied to the Arts, Manufactures, &c.

ABSTRACTS FROM FOREIGN PERIODICALS, TRANSACTIONS OF SOCIETIES, ETC.

§ 2. *Metallurgy.*

GREEN Varnish for Metal Articles.—According to the "Industrie Blättern," a green varnish for metal articles may be thus prepared:—Put as much red arsenic or mastic into a strong potash lye as will be dissolved by it, then dilute the solution with water, and add a salt of copper (vitriol, or acetate of copper). The green precipitate should be washed, dried, and dissolved in oil of turpentine. Unfortunately, mastic is too dear for the varnish to be used for all purposes.

Preservation of Metals.—Mr. CLARK, in a patent taken out last year, proposes several processes for producing metallic coatings:—

1. Electro-plating iron, first with zinc, and afterwards with lead, in such a way as to render the articles capable of resisting the action of corrosive substances.
2. Electro-plating iron with tin to render inoxidizable.
3. Electro-plating zinc with lead to protect it from the action of attacking agents.
4. Lastly, electro-plating zinc with tin to render it fit to receive or contain articles of food.

Process for finishing Bronze and Brass Articles.—M. F. DIETLEN'S process for the above purpose is as follows. When the articles, such as those used in gas apparatus, are completed, they are slightly re-heated to get rid of all trace of grease. If that is not possible on account of the solder or their form, the cleaning is performed by brushes impregnated with potash or soda lye, and the articles are dried with very dry sawdust. After this they receive a dull coating, and the projecting parts are polished with the burnisher. For polishing, grease should not be used, but simply pure water. Lastly, the articles should be brushed with chalk, subjected to flame of charcoal or alcohol, and varnished with a palette pencil or by immersion.

For the dull coating equal parts of sulphuric acid and nitric acid should be used, care being taken to put a piece of zinc in the mordant liquid during the operation. When the articles are of bright or greenish brass they must first be coloured red, which is easily done by heating them in a bath of tartrate of potass. After the coating they should be well washed with plenty of water, lest they should be covered with spots.

The varnish is made by dissolving 65 grammes (2¼ oz.) of gum lac of a clear brown colour in a mixture of half a litre (rather more than three-quarters of a pint) of alcohol, and the same quantity of spirit of wine, and adding four soup spoonfuls of turmeric flour. The whole should be exposed in a warm place for twenty-four hours, and filtered through felt. If the articles are dried a little every time a layer of varnish is deposited, the latter will form a covering of a bright gold colour, which will not be injured by being often handled. *Dingler's Polytechnisches Journal.*

Electro-Plating.—When it is required to cover delicate objects, or metallic moulds presenting very slight projections or depressions, the use of conducting powders is not to be recommended, because they give unequal conductibility, or suppress important figured details. Metallization should then be performed by reducing on the object itself certain metallic salts, particularly salts of silver.

The object is impregnated with an aqueous, or, still better, an alcoholic, solution of nitrate of silver, which can be reduced by solar light, hydrogen, phosphuretted hydrogen, sulphuretted hydrogen, arseniuretted hydrogen, or phosphorus. Solar light and hydrogen must be rejected on account of their slow and imperfect action; the above combinations of hydrogen possess eminently poisonous properties which ought to exclude them from practice, and phosphorus, though a very active reducing agent, cannot be recommended, on account of its inflammable qualities.

M. P. CAZENEUVE proposes the reduction of nitrate of silver by mercurial vapours. This process is very rapid and very safe. The nitrate of silver is dissolved in methylic alcohol (a solution containing 10 per cent.), 3 per cent of nitric acid being added to prevent the reduction of the nitrate within the alcohol. After the article has been for some time immersed in the solution, it is drained and dried, and then placed over a saturated solution of ammoniacal gas. The drying of the object is effected at a gentle temperature. The object is hung over a double-bottomed vessel, the upper bottom of which has mercury, and the lower water, which is kept boiling by a gentle flame. The article is metallized in a few minutes, and ready to be taken to the electro-plating baths.

The mercury vessel should be put under a basket funnel, to which the mercurial vapours will be conveyed. M. P. Cazeneuve has succeeded in covering leaves, flowers, insects, and other organic objects with a regular coating of copper. *Moniteur Industriel Belge, July* 10, 1876.

Rusting of Iron.—It is generally supposed that the rusting of iron depends principally on moisture and oxygen. It would appear, however, from Dr. CALVERT'S experiments, that carbonic acid is the principal agent, without which the others have little effect. Iron will not rust at all in dry oxygen, and will rust very little in moist oxygen, but very rapidly in a mixture of moist carbonic acid and oxygen. If a piece of bright iron is placed in water saturated with oxygen it will rust very little, but if the water contains carbonic acid oxidation takes place so rapidly that a black precipitate is produced in a very short time. It is known that bright iron placed in a solution of caustic alkali does not rust at all. Hence it may be concluded that the oxidation of iron may be easily prevented by the absorption of moist carbonic acid. *Moniteur Industriel Belge, July* 1, 1876.

Imitation Silvering of Iron Wire.—The following method is recommended by M. HEEREN for giving iron wire the appearance of being silvered. The wire is prepared by immersing it in a bath of sulphuric acid, in which is suspended a plate of zinc. It is taken out of this bath, brought into contact with another zinc plate, and the whole is plunged in a second bath composed of a solution of two parts of tartaric acid in 120 of water, to which are added three of perchloride of tin and three of soda. The wire is left for some hours in this bath, then polished and drawn at the draw-bench.—*Technologiste, June* 24, 1876.

Metallurgy.—The manufacture of steel is now very actively carried on, and fresh improvements are continually made. In America, rails with iron feet and Bessemer-steel flanges have lately come into use. They offer considerably greater resistance to the hammer than rails of pure steel, and it is almost impossible to perceive the line where the two metals are joined. The flux employed to obtain this perfect cohesion is composed of 50 parts of iron, 20 of silica, and 25 of aluminium.

The Foundry and Forge Society of Horme, in Ardèche, has found a means of fusing together several qualities of the same metal, or several different metals—pig-iron, wrought-iron, steel, bronze, &c. The moulding is performed in sand or plaster.

At Creuzot is now constructing a steam-hammer of colossal dimensions intended to forge great pieces of machinery in steel. This hammer, with the piston-rod, will weigh more than 59 tons. It will have a total range of nearly 16½ ft., and will have 2½ times the force of Krupp's steam-hammer. The manufacture and setting up will cost altogether about £80,000.

An immense rail, measuring upwards of 131 ft., and weighing 23 tons 12½ cwt., has been manufactured by Mr. E. THOMSON for the Philadelphia Exhibition.

In some workshops at Manchester for making boilers longitudinal rivets for boilers have been abandoned. The joints are soldered by a gas furnace and special machines. *Moniteur Industriel Belge, July* 10, 1876.

Phosphor-Bronzes.—The following analyses of specimens of phosphor-bronzes show that phosphorus enters into them in very small proportion, though it has a most useful effect.

Copper	93·68	94·11	90·86	94·71	90·34
Tin . .	5·82	5·15	8·56	4·38	8·99
Phosphorus	·17	·21	·19	·55	·76
Zinc . .	·34	·23	—	—	—

Phosphorus may be introduced directly into the alloy in a state of fusion. In this case a great part of it is lost; only a small quantity combines chemically with the metal. The copper may also be melted in a crucible, lined inside with bone-ash, nitric acid, and charcoal. This mixture should surround the copper on all sides before the closing of the crucible. *Revue Industrielle, July* 12, 1876.

§ 3. *Dyeing, Calico Printing, Bleaching, Tanning, and allied Subjects.*

Cloth-Printing Machine Pressers covered with India-rubber.—In the *Bulletin de la Société Industrielle de Rouen* an account is given of the pressers covered with india-rubber invented by M. BOURDON. Ever since 1836 fruitless attempts have been made to substitute for the endless cloth of printing machines a covering adhering to the presser. M. Bourdon's pressers are covered with two layers of india-rubber, the one black, hard, adhering to the metal, and half an inch thick; the other olive yellow, not so hard as the former, and rather more than a quarter of an inch thick. This second layer is turned at the graver, and polished with strong emery paper before being set in motion. The turning of the rollers requires certain precautions, according to circumstances.

The bulging for rollers of 6½ ft. to 7½ ft. diameter ought to be not more than about a twentieth of an inch. With more bulging the printing would be fainter at the edges than in the middle of the texture. Apart from the pressure to be given, which is less, the working is exactly the same as by the ordinary process.

The colours, whatever their mode of thickening, are worked with the usual consistence. The pressure being diminished, they do not penetrate the texture so much, and consequently give a better return. The experiments by the authors of the report were made on machines with one or two colours, but they do not doubt that they would have been equally successful on machines with several colours.

When by chance a hard substance, such as a nail, passing between the doubler and the presser is indented in the covering of the latter, all that is necessary is to pour into the indentation a mixture of gutta-percha and india-rubber, melted with a hot iron, removing the excess with a very fine file.

The reporters, comparing the expenses occasioned by the use of endless cloth with those of the vulcanized presser, reckon the latter not much more than one-fourth of the former; there is also a considerable saving in labour.

It has been found that whenever a machine with two colours is stopped, and the presser removed, the pattern is not displaced, as is the case with the endless cloth.

Cheap Substitute for Gum Tragacanth.—Herr C. BOSCHAN, of Vienna, has ascertained by experiment that a combination of twenty parts by weight of starch, six parts of glue, and two of glycerine boiled in water, perfectly answers every purpose of tragacanth, and can be used with equal advantage. For finishers of textile fabrics it may be interesting to know also, that a mixture of six parts of starch and three of glycerine gives a perfectly transparent, colourless finishing, which till now has not been discovered, as the yellow tint of glazed linen and shirtings abundantly proves. This finishing, through the absence of glue, is far cheaper than the ordinary article, without being at all inferior to it in appearance. *Stummer's Ingenieur.*

Mechanical Drying of Silk and other Threads.—The drying of silks is performed mechanically, according to M. BOIRIVANT'S method, by means of a cylindrical drum with twenty radii from 5 to 6½ feet long. The dryer is moved by a vertical shaft which is set in motion by a gear of toothed wheels. This apparatus is furnished at its centre with three internal slide ventilators attached to the axis of the drum which sets them in motion. The threads to be dried, in skeins or hanks, or any other state, are arranged on rollers in a vertical plane, and attached to pulleys which give them a rotatory motion. *Moniteur Industriel Belge, July* 10, 1876.

Red Ink.—The following receipt for making a beautiful red ink is given by M. METRA, of Paris. Dissolve 16 dwts. of saffranine in 17½ oz. of warm glycerine; add, while carefully stirring, first, 17½ oz. of alcohol and then 17½ oz. of vinegar, and lastly, dilute the whole with two gallons of water in which some gum is dissolved. *Der Arbeitgeber.*

Dyeing of Ornamental Feathers.—Ornamental feathers are, as is known, first carefully freed from grease in a bath of carbonate of ammonia or a weak soda lye, then dried with gentle shaking, to preserve their softness and graceful form. They were formerly scarcely dyed at all, except black with logwood and quercitron, or prepared catechu and a few other colours, but, since the discovery of colouring matters extracted from tar, various elegant colours have been applied to them.

Aniline colours are applied to ornamental feathers without any other preparation than a tepid bath. For bright colours, the feathers, after being freed from grease, are put into a chamber, where they are exposed to sulphur vapour. The dyeing bath is very simply prepared by pouring a filtered solution of aniline colours into the tepid water, and the feathers, after having been cleaned and subjected to the sulphur, are manipulated in this bath till they have acquired the desired shade of colour. They are then washed, tied to threads, and shaken in the air till they have resumed their natural brightness, and afterwards powdered with gypsum or oiled.

They are dyed red with a weak solution of fuchsine, magenta with a more concentrated solution, violet with patent violet soluble in water, bluish red and reddish blue with Lyons blue soluble in water, and greenish blue with light blue soluble in water.

Feathers may be dyed fast alkaline blue by dissolving in the bath an ounce of soda, pouring into it the solution of alkaline blue, dyeing bright blue in the bath, and plunging into a bath previously prepared with an ounce of sulphuric acid. The blue is brightened as usual.

Green is produced by treating with a solution of iodine green, orange by a solution of yellow coralline, deep red by a solution of red coralline. A solution of yellow coralline turns, on the addition of ammonia, from orange red to red, and the red solution, on an addition of acetic acid, from red to orange. Consequently, by an addition of liquid ammonia to the solution, all shades may be obtained with yellow coralline, and the feathers dyed with them. Coralline crimson is more beautiful than the same tints produced on textures, only it does not stand well, which is of little consequence for feathers. With coralline the plunging into a soda lye must be avoided, and the feathers oiled immediately.

For white, feathers treated with sulphur are blued with a very weak solution of bluish patent violet, but in other respects treated like the rest.

Latterly it has been the practice to give the extremity of the

plumules an orange tint, obtained by dissolving in the water-bath bluish or reddish patent violet in alcohol at 194° Fahr., and impregnating the plumes, which are already prepared and oiled with a camel-hair brush in the parts that are to be bronzed, with this solution. The alcohol rapidly evaporates, and leaves a beautiful bronze tint. Only violet soluble in alcohol is employed in this operation, since that which is soluble in water is easily discoloured by contact with the fingers. *Färber-Zeitung.*

Dyeing of Glazed Skins.—Glazed skins, especially those dyed brown, which, with those dyed grey, are now most in demand, are found in the most varied tints, from the brightest yellow brown to red brown and the deepest brown, but it is sufficient to know how to prepare baths for bright, medium, and deep brown, to obtain with these types all the baths of other tints. They are composed as follows :—

1. For bright brown:—38½ gallons of water, 6½ lbs. of alder bark, 2·2 pounds of fustic, 8¾ oz. of yellow wood, 2¾ oz. of Brazil dye-wood, 1½ oz. of logwood.

2. For medium brown :—36½ gallons of water, 4·4 lbs. yellow wood, 2·2 pounds fustic, 1¾ oz. Bablah, 8¾ oz. quercitron bark, 8¾ oz. Brazil dyewood, 4¼ oz. logwood.

3. For deep brown:—43 gallons of water, 4·4 lbs. fustic, 17½ oz. yellow wood, 8¾ oz. quercitron bark, 4¼ oz. Brazil wood, 30½ oz. logwood, and solution of indigo carmine according to requirement.

For every 2·2 lbs. of wood, 8¾ gallons of water are taken. In the same way as with indigo carmine, yellow berries or aniline colours may be added according to the shade desired. Instead of alder bark, willow bark may be used. In many German establishments a decoction of spent fir bark is used, but in France alder is preferred, because, on account of the small quantity of tannin in its bark, the grain appears finer, softer, and more delicate. Bablah, like fir bark, is very astringent, and should not be employed without care, because it closes up very much. It is especially applied to skins with strong grain, or those which, in consequence of incomplete tanning, do not easily take colour. This is a significant example of the use of astringents as agents of fixation. These agents are useful for dyeing baths only within certain limits. If used in excess they are injurious. They give hardness to the colours on skins completely tanned, and always a rough appearance. According as one or the other of these astringents is employed, choice must be made between fustic, which is rich in tannin, and yellow wood, which is poor in it. For this reason the formula for deep brown contains only colouring woods properly so called. These woods, especially Brazil or redwood and logwood, are prescribed only in the proportion suitable for putting into the bath nothing but the necessary tannin. *Der Gerber.*

The Production of Coal-Tar.—The annual production of coal-tar is very considerable. England produces 120,000 to 130,000 tons, Belgium 10,000 tons, France 30,000 to 35,000 tons. Before the development of new branches of industry, including among others the manufacture of aniline colours, the price of coal-tar in France was from 5*s.* to 8*s.* a ton. It is now £2 8*s.* to £3 12*s.* a ton. *Moniteur Industriel Belge, July* 10, 1876.

Dyeing the Yellow of Picric Acid and Naphthylamine on Wool.—To produce the yellow of picric acid and that of naphthylamine on wool, take for 220 lbs. of woollen yarn,

14 oz. of picric acid,
2·2 lbs. of Glauber's salt,
2·2 lbs. of alum,
5½ oz. of sulphuric acid.

These substances are to be dissolved in hot water raised to boiling point. The yarn should be put into this bath at the temperature of about 104° Fahr. It should then be boiled for an hour and lightly washed, the desired tone being developed in a bath of naphthylamine yellow. *Technologiste, June* 17, 1876.

Silicious Lac Dyes.—It is known that if a solution of alumina is poured into solutions of various colouring matters, all the colour is precipitated in forms to which the name of "lacs" has been given. M. R. BÖTTGER states that when an alcoholic solution of any of the colours which are extracted from tar is mixed with a sufficient quantity of "fossil meal," or infusorial earth, one need only add water and filter the mixture, for the liquid to flow clear while the earth retains all the colour. It is probable that in this way silicious lacs capable of being applied to many purposes might be obtained at a low price. *Technologiste, June* 17, 1876.

§ 4. *Food and Sanitary Matters.*

Richness in Starch of Potatoes of Various Sizes.—The Vienna Journal of Agriculture states that M. E. POTT has made many experiments to ascertain the quantity of starch contained in large and small potatoes. He took twenty red kidney potatoes of different sizes, and found that the ten large ones had, on the average, a richness in starch of 19 per cent., and the ten small ones only 17·2 per cent. This is of importance in practice, and deserves the more attention that it is often falsely supposed that middle-sized potatoes of every kind are richest in starch.

It follows from these experiments that for setting and distillation the largest potatoes should be used as much as possible; but, on the other hand, for feeding cattle and domestic purposes preference should be given to small potatoes, which are proportionally richer in nitrogen. *Technologiste, June* 17, 1876.

Drying Powder to prevent the Marks of Small-pox.—In several cases the marks of small-pox have been prevented by the use of a powder composed of four parts of flour of sulphur and one of red precipitate. The powder should be put on a thin layer of glycerine previously spread over the pustules when they have reached suppuration. The glycerine ensures the adhesion of the powder, which dries, forms a crust, and on being removed leaves the skin free from scars. *Les Mondes, June* 15, 1875.

Sugar and Water as a Remedy for Lime in the Eyes.—Every one who has to do with building knows how dangerous lime is, if, by accident, it gets into the eyes. The corrosive action of lime may be neutralized by cold sugar and water, the lime combining with the sugar into a compound which does not attack the eye. *Communication from the Architects' and Engineers' Society in Bohemia.*

The Antiseptic Properties of Madder Root.—M. de ROSTAING, in a communication to the French Academy of Sciences, states, that some meat was preserved for seven months in a jar containing powdered madder-root which was opened a dozen times. The weight of the meat was reduced from 119 grammes (4·19 oz.) to 25 grammes (·88 oz.) without giving any indication of putrefaction. M. de Rostaing suggests that madder should be employed for preserving corpses and rendering cemeteries healthy. *Comptes rendus, lxxxii.*

Egg Preparations.—In a previous number (p. 212) a brief account was given of the preparation of condensed eggs at Passau. It appears that the proprietor of the factory, Herr von EFFNER, was a lieutenant in the Bavarian army, and having been disabled by wounds in the war between Germany and France, he devoted his attention to the production of pure and portable egg preparations, that would keep well and might serve as food for the army on the march or in garrison. The excellent quality of his preparations—especially the dried and powdered yolk—has been fully established by experiment, both at the Polytechnic Society and the Physiological Institute at Munich. In a communication to the Berlin Chemical Society, Professor Bohl makes the following remarks :—

For some years egg preparations containing an addition of salt or sugar have been sold for culinary and technical purposes. Through the addition of between 12 and 36 per cent. of foreign substances the consumer is never sure as to the real value of the product, unless he knows the proportions of the ingredients. Herr von Effner's egg preparations are without any foreign addition, and are produced by simply steaming in a vacuum. and afterwards pulverizing.

There are three distinct products—preparations of the whole egg, of the yolk, and of the white. The first two are a bright yellow-white powder, which, mixed with cold water, forms emulsions possessing all the properties of the fresh egg and yolk. The prepared white of egg is a glass-like, sandy, pale yellow powder, which is almost completely dissolved in tepid water, and then exhibits all the properties of the fresh white of egg. All the preparations can be used for culinary purposes of every kind, and experiment has proved that those of the yolk and the white may also be advantageously employed for technical purposes, as for preparing glove-leather, printing textile fabrics, &c.

Chemical analysis shows an entire absence of foreign substances, and about 90 per cent of nutriment. *Buchner's Neues Repertorium für Pharmacie.*

Fermentation of Beer.—One of the great difficulties experienced by brewers in obtaining a regular fermentation at all seasons of the year, seems to have been successfully met by Mr. H. B. BARLOW, of Manchester. To purify the air before making use of it to cool the mash-tub, he draws it through an asbestos filter. The vat of the cooler is consequently exposed to the action of purified air, and moreover the cellars in which fermentation takes place are divided into compartments fed by purified and compressed air, which is cooled by passing through ice. Lastly, the cellars are kept cool by metal chests filled with a mixture of ice-water and sea-salt.

§ 5. *Fuel, Heating, Illumination, &c.*

Petroleum in Europe.—According to the estimate of M. C. FOUCAULT, the country of Roumania alone could furnish sufficient petroleum for the consumption of the whole of Europe. In his exploration of the valley of the Danube he has ascertained the existence of numerous springs, the produce of which ought to be considerable. At present the total yearly export of petroleum from Roumania does not amount to more than £40,000, for want of enterprise and capital. *Moniteur Industriel Belge, July* 10, 1876.

§ 6. *Miscellaneous.*

A New Source of Paper.—In the French island of Guadaloupe, paper is said to be manufactured out of the refuse of the sugar-cane, and to be in great repute for its quality, strength, fine grain, and smooth surface. *Illustrirte Zeitung, May* 15, 1876.

The Dangers of Dynamite.—The explosion of dynamite is caused by a violent shock or the detonation of another fulminating material mixed with it. Fulminate of mercury has a very powerful action of this sort. The dangers of handling dynamite may be comprised under two leading heads. The dynamite, and especially the cartridges, ought to be kept in a warm place, that they may not harden, and it is often necessary to heat the primed cartridges that have been for some time in the trenches. This is done by putting them on a hot stove, and as this operation is often repeated several times, it happens that the fulminate of mercury detonates and causes the explosion of the dynamite.

Another cause of accidental detonation arises from the property which fulminate of mercury possesses of crystallizing into long needles in the mixture of alcohol and nitrate of mercury employed in its preparation. These needles, which consist of octahedral crystals, easily break and crack, and the more so the larger they are. To avoid this danger, the fulminate of mercury is worked up with water and sulphur, or saltpetre, on a marble table. By this operation crystallization is prevented as long as the capsules are kept in a dry place. But when they come into prolonged contact with damp air, the fulminate of mercury gets into needles, which are deposited on the inside surfaces of the cartridges. When they are pinched with pincers, as is customary, the crystals break and crack, to the fatal injury of the workman.

It is equally dangerous to keep primed cartridges long. In consequence of the pressure of the capsule the explosive material, which was compact, becomes disintegrated, and presents a much larger surface to the damp air. Hence results a crystallization of the fulminate, which may occasion an explosion when the hole in the mine is charged.

The above two kinds of danger may be obviated by the use of oiled-paper primers, which contain a long tin capsule with a very fine mixture of chlorate of potass and sulphide of antimony. The explosive material is simply poured into the capsules, to which it does not adhere, and they are protected from shocks. The explosive material itself is a mixture and chemical combination of such a character that the crystallization of one of the elements cannot have serious results, because no one of them is explosive by itself. Such a capsule may be flattened on a stove with a piece of wood without any explosion.

When the holes in the mines are charged, the dynamite cartridges are simply fastened on the primers. As in this process the two are in contact for only a very short time, and as on the other hand explosion cannot then be caused without the electric spark, this method ought to have the preference everywhere. *Revue Industrielle, July* 5, 1876.

Liquid for Heating to a High Temperature.—It is often necessary to surround the pipes of heating or evaporation apparatus, and hot-air apparatus, ovens, stoves, &c., with a boiling liquid at a temperature above 212° Fahr. It is also necessary to make use of water baths producing high temperatures. The liquid employed for this purpose is simply water in which sea salt has been dissolved. Oil baths, &c., are also used.

Messrs. GRIMM and CORVIN propose instead of these various agents to make use of a solution of chloride of lime in glycerine, a solution which does not boil below 572° to 626° Fahr., and has the further advantages of never attacking metals nor congealing. *Technologiste, June* 17, 1876.

Essence of Bergamot.—The authorities of Reggio Calabria, in America, offer a reward of £2,000 to the inventor of the best apparatus for extracting essence of bergamot from oil. The conditions are severe : the apparatus must be cheap, producing the greatest quantity of essence in the shortest time, and that without at all injuring the purity, colour, and smell of the product. *Moniteur Industriel Belge, June* 10, 1876.

Artificial Meerschaum and Coral.—Excellent imitations of meerschaum and coral are manufactured in America with potatoes and carrots. For meerschaum, potatoes are peeled and left to soak for thirty-six hours in water acidulated with 8 per cent. of sulphuric acid. They are then dried between sheets of blotting paper, and pressed in a bath of hot sand, on plates of chalk or plaster, for several days. These plates of chalk or plaster must be renewed every day. The substance thus obtained can be easily sculptured. If more hardness, whiteness, and elasticity are desired, the potatoes are soaked in a solution containing 3 per cent. of soda instead of sulphuric acid. Artificial horn may be thus prepared by exposing the potatoes subjected to the above treatment, to the action of a boiling solution containing 19 per cent. of soda.

By substituting carrots for potatoes artificial coral is obtained. *Revue Industrielle, June* 21, 1876.

Glass obtained by means of Blast-Furnace Dross.—Mr. BASHLEY BRITTEN is the inventor of a process for transforming dross into glass directly on coming from the blast furnace. This glass is perfectly transparent, and of a good colour. Thus a substance is utilized which has been hitherto of no value, and advantage is taken of all the heat it contains on leaving the furnace. The process has been successfully employed at the ironworks of Messrs. Cheshland and Fisher, near Wellingborough.

The fused dross is conveyed to vats containing about 15 cwt., there mixed with other substances, and changed to glass in a very short time. This glass has been found very plastic, is exempt from the action of acids, and may take the place of the best bottle glass. Diamond cuts it easily, and it may be used for greenhouses, roofs, &c., and other purposes for which ordinary glass is too costly.

Vegetable Leather.—Under the name of "French vegetable leather," a substance invented by M. JOLLISSAINT VONECHE of Paris, which is thus prepared, has been introduced into commerce. Uniformly thick wadding of cotton refuse, or cotton itself, is laid upon a polished hot zinc-plate, and over it is poured a concentrated decoction of *Fucus crispus* or pearl moss, or any other species of fucus. It is then pressed between two rollers, the distance between which decides the thickness of the artificial leather. After the pressing, the substance is covered with boiling linseed oil and dried. Lastly, the dried sheet is covered with a thin coating of vegetable wax, and again rolled between chamfered rollers to make it flexible.

To produce a cheap substitute for sole-leather, the slimy decoction is mixed with cotton flue, till a thick pulp is produced, which is spread out on zinc-plates, and thinly covered on both sides with cotton waste, then dried and covered with boiling linseed oil, and lastly pressed hard between two zinc plates in a hydraulic press. *Der Arbeitgeber.*

Furniture Polish.—The following is a good preparation for polishing articles of furniture, objects covered with leather, floors, &c. Let 51 grammes (1¾ oz.) of stearine finely shaved be put in 72 grammes (2½ oz.) of heated oil of turpentine, and after being melted, be left to cool. A salve will be produced which should be applied in small quantities to a woollen rag. The article to be polished must be well rubbed with this, and lastly wiped with a clean dry cloth. *Polytechnisches Notiz-Blatt.*

Restaurant Railway Cars.—The directors of the Central Michigan Railway have introduced restaurant cars which have proved very successful. The cars are completely free from all disagreeable motion, so that it is possible to dine as comfortably on the line as in an hotel. *Revue Industrielle, July* 12.

Artificial Wax.—To make artificial wax, melt resin with half its weight of paraffin or other carburet of hydrogen, without exceeding the temperature of 226° Fah. To the resin may also be added a third of its weight of tallow or stearic acid, which may be afterwards neutralized by potass. *Revue Industrielle, July* 12, 1876.

Manufacture of Artificial Leather from Leather Refuse.—A patent has been taken out by M. SÖRENSEN, of Copenhagen for turning to account the great quantity of leather refuse which would otherwise be lost to industry. If the refuse is in a dirty state, it must first be freed from all foreign substances, and afterwards reduced to a uniform fibrous material in a machine constructed for the purpose. This is done by

grinding, tearing, crushing, cutting, or rubbing. This leather, thus finely divided, being mixed with ammonium water, a gelatinous mass is produced, which, being pressed in forms or rolled out into plates and dried, becomes a very hard and stiff substance of considerable cohesive power, but without elasticity and soluble in water. To make it elastic and neutralize the effect of water, it is mixed with india-rubber, and the following process is employed. The india-rubber, which may be of the finest or poorest quality, is crushed and washed in a washing-machine consisting of two fluted steel rollers, on which a jet of water is directed for the twofold purpose of washing the india-rubber clean, and at the same time protecting it from burning by friction. After the washing, the india-rubber is dried, cut into small pieces, and dissolved by oil of turpentine, benzine, sulphuret of carbon, or other suitable fluid. The quantity of the dissolving material is determined by the quality of the india-rubber. Para india-rubber can be dissolved or sufficiently distended by 4 parts of the fluid, Central American "scraps" by $3\frac{1}{2}$ parts, Guayaquil india-rubber by 3 parts, and African by $2\frac{1}{2}$. The india-rubber so prepared is then mixed with ammonium water and well stirred up. Then the prepared leather is put into a close-shutting kneading machine, to derive as much benefit as possible from the ammonium vapours. The mixing proportion depends on the intended quality of the fabric; thus for soles it is :—

25 parts of firm india-rubber,
67 „ ammonia,
67 „ leather.

For heels—

25 parts of india-rubber,
80 „ ammonia,
80 „ leather.

For inner soles—

25 parts of india-rubber,
75 „ ammonia,
90 „ leather.

After the kneading, which is continued till the mass is perfectly homogeneous and smooth, it is either pressed into forms or rolled into lengths, then dried, and during the drying subjected to degrees of pressure varying according to the intended uses of the fabric. For soles, the greatest pressure of 6,000 lbs. to the square inch, is employed. When pressed, the fabric is either coloured or varnished or dressed up in some other way to look as much like leather as possible. *Bayerisches Industrie und Gewerbe Blatt, May*, 1876.

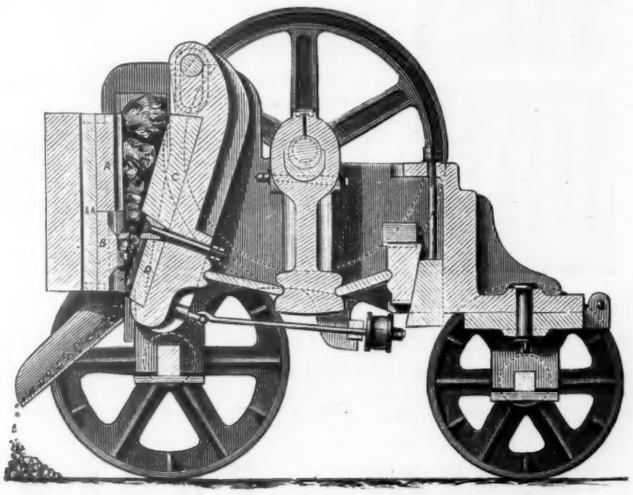


Fig. 1.

MARSDEN'S IMPROVED STONE AND ORE CRUSHING MACHINE.

THE January number (1876) of the PRACTICAL MAGAZINE contained a portrait and memoir of Mr. Marsden, the Mayor of Leeds at the time of the visit of the Prince of Wales to that famous town; and it may be remembered that in the early part of his career he occupied a humble position, but being apprenticed to one of the best citizens any town could wish to claim, he obtained the respect of that generation by his good conduct and the use he made of his talents and opportunities; further, that he went to America, and there joined a leading engineer of the name of Blake. Road-making orders were embarrassing both constructors and municipal authorities, and Blake and Marsden brought out a stone-breaker. It succeeded beyond all expectation, and Marsden came back to Leeds, having made a considerable sum, and bringing the sole right to Blake's patent in England in his pocket. We were in the same position here as they in America, for in both countries not only was such a machine required for road-making but for ore-crushing. Marsden improved upon the original, and by his energy, skill, and indomitable perseverance made his machine famous throughout Great Britain, from whence it found a market in our colonies; he became a large employer of labour, rose to a position in municipal affairs, and ultimately reached the distinction of the mayoralty in the town from whence he had gone out.

As remodelled, it consists of a machine with cubing jaw for breaking road metal, with a screen for dividing the material into required sizes; a pulverizing machine; patent lever machine for grinding and pulverizing mineral and all ores, which can be worked by hand or by steam, but steam is preferable. The cubing jaw is Mr. Marsden's specialty, and it is that which gives Blake's machine the position it holds against all rivals. The first-class prize medals have been taken at every exhibition, where its operation is watched with eager curiosity. The large blocks are brought under its action and reduced to any size at a cost of twopence or threepence a ton. It is at home whether breaking road material, pyrites, sulphur, stone, emery, furnace waste, ores, limestone, rock salt, or any of those substances used in manufacturing cement, concrete, artificial stone, or asphalte combinations. The saving it has effected is immense. There are now 800 in use, and one fact will show the value of the invention to the public. The St. John del Rey Mining Company purchased one for £180, and also an engine, making a total cost, including carriage and fixing, of £500. By that outlay the labour of fifty-five persons was dispensed with, and a saving of £600 a year effected. It only requires five labourers to feed, to engineer, to supply fuel and oil; and after making a good allowance for interest the saving was enormous. The one is twopence per ton and the other one and eightpence, or threepence against two and sixpence.

Several are at work in the mines of South America and Japan, and being made in several forms and sizes the explorer who can only journey by mules can take with him a portable one, no piece of which weighs more than $2\frac{1}{2}$ cwt. The quantity of work it can get through was seen at the Cardiff meeting. It was ninety tons in a ten-hours day; and the small engine at another place, having only a $7\frac{1}{2}$-inch cylinder, not only drove the machine and crushed seventy-five tons a day, but worked a pump of 6 in. diameter to drain the bed of the reservoir.

Blake's stone-crusher is familiar to all observers of inventions, and we therefore illustrate the machine as it is improved. (Fig. 1.) One of these is placed on each side of the driving engine. The improvement is in the cubing jaw, fig. 2, in which the pitch of

the teeth in the sections is much coarser in the top than in the lower one. Each section is made to turn end for end when the teeth are worn and therefore are reversible. They are cast on the hardest metal chills, but having wrought-iron bars cast on the back are easily fitted or planed. The white-metal joint is superseded by a soft cast-iron plate, A A, with planed fitting strips on one side, against which the fixed jaws bear. The jaw stock is also planed. The lips in the swing jaw are slightly

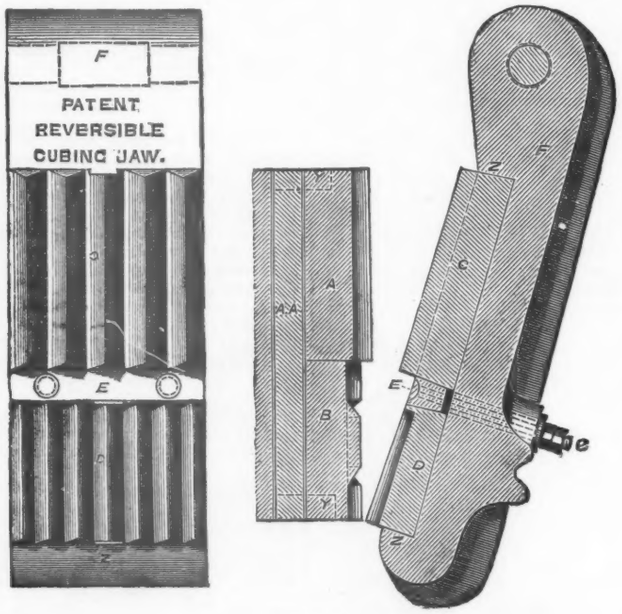
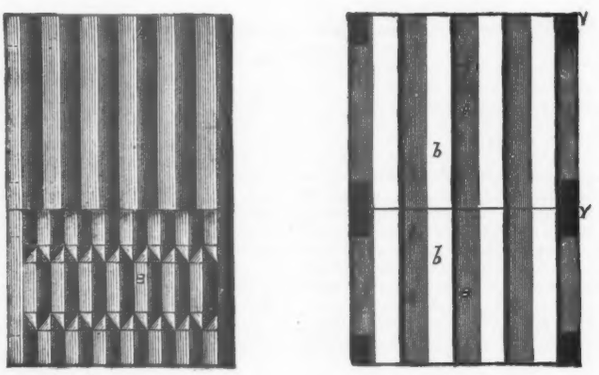


Fig. 2.

undercut, causing the wedge piece E to draw them by forcing them outwards, but it is held by lock, nuts, and pin at the back, and a recess and tongue at Z hold each section sideways. The teeth of the top sections are arranged ridge and furrow, and the bottom tooth and tooth fashion (fig. 3). The lower sections are recessed back, and the first operation is therefore to sledge the



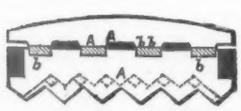


Fig. 3.

stone, which drops into the cavity and is finally squared or cubed at the bottom, besides which it is more tumbled about and put into better form for smashing by the break in the jaw ribs. Either of the sections can be reversed without the other. The pitch of the teeth at the bottom is 1½ in., 1¾ in., 2 in., 2¼ in., and 2½ in., as the desired size of the road-metal may prescribe, but the usual size is 2 in. This was exhibited last week at the Birmingham meeting of the Royal Agricultural Society.

Engineering, Building, &c.

ABSTRACTS FROM FOREIGN PERIODICALS.

§ 1. *Engineering.*

FIRE-Diving Apparatus.—Practical experiments were lately made at Berlin with Herr OEFTBERG'S apparatus for enabling persons to penetrate fire and move about in the midst of flames without injury. The costume consists of two coverings, the inner made of india-rubber, and the outer of leather. The head is covered with a helmet like those of divers, with two openings in front to look through.

A single pipe fastened to the girdle conveys both air and water. The air-pipe, fed by a pair of bellows, is inside the water-pipe, and conveys the air, cooled by the water, to the inner part of the costume. The air inflates the costume and then escapes through the two small sight-holes. By this constant current of air not only is air continually supplied, but smoke and flame are blown away.

The water-pipe is divided at the back into two halves, one of which branches off as an extinguishing pipe, while the other, leading to the outside of the costume, continually pours streams of water over it through many small channels, and thus surrounds the apparatus with a flowing layer of water. Valves for the regulation of the streams of air and water are ingeniously contrived.

The apparatus underwent the recent trial with complete success. The fire-diver was able to remain quite twenty minutes in a square of lighted wood-heaps, which sent forth a heat from the outside preventing approach within twenty paces. The firm of Brandt and Nawrocki, of Berlin, are the sole agents for the sale of the apparatus. *Deutsche Industrie Zeitung.*

Sharpening Tools.—It has long been known that a razor gets a fine edge if it is laid for half an hour in a saucer with water containing a twentieth part of its weight of muriatic or sulphuric acid. When taken out, it is gently wiped, and sharpened after a few hours on a whetstone. The acid supplies the place of the grindstone, and nothing more than a good whetting is required. The acid bath is not at all injurious to the blade; it has even been found by experiment that badly tempered blades are improved by it.

In France it has for years been customary to sharpen scythes in a similar way. The scythe is laid for half an hour before use in water, containing a twenty-fourth part of sulphuric acid, and a uniform sharpness all along it is induced by passing a soft sandstone over it. No harm is done by leaving it longer in the acidulated water, provided it is wiped clean and dry. Other instruments may be sharpened in a similar manner. *Deutsche Tischler Zeitung.*

Curving of Metal Pipes.—Mr. ORUM of Philadelphia has obtained a patent for avoiding the filling with pitch and sand of pipes to be curved, by making use of a spiral spring made of square wire. After the curving, the spring is withdrawn by turning it in the opposite direction to that in which it was inserted.

The "Franklin Institute Journal" states that pipes from 40 to 170 ft. long in copper, brass, iron, and tin can be easily curved by this process.

Magneto-electric Bell Apparatus.—Electric bells are very liable to get out of order, and the batteries must be very carefully attended to, if they are to work steadily. For persons who are not acquainted with electricity, Messrs. SIEMENS have constructed a magneto-electric inductor likely to obviate all inconvenience. A Siemens armour, turning under the action of a crank in the midst of six permanent magnets, produces the electric current which acts on the bells. This apparatus gives a constant current, is very simple, and requires scarcely any attention. To set a bell at work placed at a distance, nothing more is required than to turn the crank of the inductor. The Siemens apparatus may be fixed to a wall, or placed in a box. It occupies very little room. *Moniteur Industriel Belge, June* 10, 1876.

The Bathometer.—This title is given to an invention of Dr. W. SIEMENS for measuring depth. This skilful engineer takes a vertical tube full of mercury, like a barometer, only the tube is of steel, and widens at its two extremities in the shape of a cup, to increase the terminal surface of the mercury. Then the lower cup is closed by a sheet of flexible steel, on which the whole weight of the column of mercury rests. Two powerful springs which go along the tube support the thin sheet of steel at its centre, and consequently the weight of the mercury. The liquid is in some sort suspended on the springs. If the weight of the column increases, the springs give way and the sheet bends; if the weight diminishes, the springs restore the sheet to its original state.

But it is evident that, when the sheet of steel bends, the level of the mercury in the upper cup sinks, and conversely it rises if the sheet is forced inwards. The changes of level of the liquid in the upper cup consequently indicate the changes of weight. Hence it is only necessary to register automatically by a very simple electric system the fluctuations of the mercury, in order to know at every instant what is the variation of weight, and from that what is the depth. The bathometer indicates changes of gravitation, as the barometer indicates changes of atmospheric pressure.

Evidently nothing more is needed than to cast a glance at its indications, in order to know immediately whether you have much or little water below you, whether you are passing over a valley or a submarine mountain. When the curves of the level of the ocean are obtained, a ship will be able to determine its position without astronomical calculations in case of need, by the mere knowledge of the depth from the indications of the bathometer. The instrument has already assisted in finding the end of an electric cable lost at the bottom of the sea, and in two voyages it has given the depths within a tenth. In fact, with the bathometer is obtained, not the exact depth under the ship's keel, but the average depth of a certain neighbouring zone which influences the instrument by its attraction. If the expectations to which the bathometer gives rise are fulfilled, Dr. W. Siemens will have created one of the most powerful instruments of investigation that modern physical science can possess. *H. de Parville, in the Bulletin Français.*

FIRE-ENGINES.

THE exigencies of commercial life render the study of fire-engines an essential part of the education of manufacturers, proprietors, and philanthropists. No security that has been devised will cover the loss to which these are exposed from the occurrence of a fire, because, even with the extra insurance which some offices will grant in the matter of time for repairs, nothing can possibly cover the loss that must accrue.

The ancients had many contrivances for meeting this peril, but their use was costly and they could only be adopted by the rich. Juvenal tells us that "the opulent Licinus bids his train of servants watch by night, the water-buckets being set ready,—alarmed on account of his store of amber, statues, his Phrygian column, and his ivory, and broad tortoiseshell;" and Pliny speaks of syphons being used to put out fires. There were bands of firemen at Rome in the time of Augustus; and at the present time the Orientals have large syringes to put out fires.

We are indebted to the Greeks for machines of this description; one Ctesibus, in the time of Ptolemy Philadelphus, a maker of pumps, is said to be the inventor, and his pupil, Hero, mentions a forcing-pump of two cylinders for extinguishing fires. Trajan's architect describes a machine of leathern bottles with attached pipes which were worked by squeezing, but Hautsch of Nuremberg made, in 1657, the first movable one, consisting of a water-cistern, 8 ft. × 4 ft. × 2 ft., built on a sledge; it was worked by 28 men; it could force a stream 1 in. in diameter to a height of 80 ft., and is supposed to have been worked by a horizontal cylinder and piston, with a pump-like action. Duperrier obtained from the King of France, forty years afterwards, a patent for portable pumps, which he covenanted to keep in working order; but they were costly: at the end of twenty years the State had to pay annually 20,000 livres. Then followed the invention of flexible hose and the air-chamber. The former is due to Hautsch, though not generally used until long after his time; but the latter is much later. It is based on an important pneumatic law, viz., the increased elasticity of compressed air. This gave continuity to the stream, and became a valuable aid in hydraulic engineering of every kind; but so late as 1720 no greater height than 30 ft. could be attained.

On the introduction of these engines into England, Simpkin, the predecessor of Messrs. Merryweather and other inventors, made several improvements, but the air-chamber principle remained; the changes were chiefly in matters of detail. Before the introduction of the steam fire-engine these multiplied, but it

MERRYWEATHER'S STEAM FIRE ENGINE.

MERRYWEATHER'S PRIZE MANUAL FIRE ENGINE.

is curious to note that for the most part they aimed at the exclusion of mud and gravel from the engine. As we now regard matters, this might seem to have been a frivolous object. It was nothing of the kind. We have been present at country fires forty years ago, and have seen that the least impediment would stop the whole hope of the neighbourhood. The water had to be obtained in hot haste from the bed of a low stream some 500 yards off, and supplied to the engine by buckets passed from hand to hand. It is manifest that in filling these buckets in such a scene they would scrape the edge of the stream, and lots of gravel and mud be carried forward to the trough of the engine, soon choking the low tap of water and blocking the passage. The first thing to be done was to have an engine made of metal, that would run on wheels just as the others did, and would provide a much deeper reservoir than a wooden one, because there could be a trough to take the ballast-stuff. Mr. Tilley made one, but Mr. Merryweather made one more portable and more efficient. His became the engine generally adopted as a stationary engine for the protection of large buildings; and he had his reward in the patronage of the Duke of Devonshire, the Duke of Northumberland, and the Duke of Rutland.

This brings us to the change inaugurated in 1829, from which sprang the steam fire-engine. John Ericsson, whose name is not unknown to our readers, in conjunction with John Braithwaite, patented a principle for generating steam, and an engine on that construction was employed for putting out a fire which occurred at the Argyle Rooms, London, in 1830. In our notice of the Loan Collection at the Science and Art Rooms at Kensington, we referred to Mr. Braithwaite's "Novelty," and it is the application of that principle which made our present fire-engine. Into that history we cannot digress. Suffice it to say that, weighing 45 cwt., consuming 3 bushels of coal in 5 hours, it was honoured for propelling 30 to 40 tons an hour to a height of 80 or 90 ft., and that after the alarm of fire was given it could be at boiling heat in 18 minutes.

The steam fire-engines exclusively made by Messrs. MERRYWEATHER have these peculiarities: one, direct-acting *long* stroke, steady running, without crank, crank shaft, connecting rod, or fly-wheel, steam cylinder and pump being horizontal. These are from the joint designs of R. M. Merryweather and Edward Field, C. E., and are strictly reciprocating engines, there being no rotary motion in the whole machine; by which means much complication and weight are saved, thereby allowing extra strength to be given where it is most required. The motion is regular throughout the stroke, and the engines can be started when in any position, never stick, and can be worked to any speed up to the maximum with perfect certainty and ease, the motion being obtained by a cross-head on the piston-rods actuating a twisted bar, which, by means of a short lever, shifts the slides at the required part of the stroke. The water is inside the tubes, which hang down in the fire and are surrounded therewith at a temperature of 3,000°. The boiler is much smaller than others of equal power, and of lesser weight and size, and has larger steam and water spaces. It is secured from explosion from any careless lack of water-supply, because the escaping steam from the tubes acts on fusible plugs without much damage; and if the tubes are burnt they are easily replaced in a few hours, and such spare tubes, costing only three shillings, can be kept always ready for fixing, which is a simple operation, and can be performed by an ordinary workman. This boiler excels also in the important matter of the consumption of fuel and in its period of service. There is none so economical or more lasting; some have been twelve or thirteen years at work, and still continue, and this is attributable to the perfect exposure of the entire heating surface to the hottest part of the flame and the powerful circulation of water caused by the arrangement of the circulating within the hanging tubes. This rapid circulation, moreover, tends to keep the tubes free from filth and deposit, even where the water is charged with lime. The machinery is in front of the boiler, and hence the furnace-door is easy of access and the stoking can be done while the engine is travelling to the fire.

Since the introduction of the valve motion, patented by this firm for their engines, it has been adopted by all the best pump makers, and has nearly driven out fly-wheels and cranks. By it the engine can go at any speed, sending out 2,000 gallons a minute or only one; and its working is certain and secure and simple.

A small outlay will make all these fire-engines adapted to consume wood instead of coal, which is an important consideration in the colonies and in many parts of the continents in both hemispheres.

In illustration, we can only supply a few examples. The Patent Single-Cylinder Engine is extensively used: twelve by the London Fire Brigade; three in that of Paris; and in the provinces, at Cardiff, Plymouth, Liverpool, Coventry, and Twickenham, &c. The leading ship-building firms, chemical works, railways, distillers, and the great mansions of the country (such as that of Lord Derby at Knowsley, of the Marquis of Exeter at Burleigh, of Lord Leconfield at Petworth, of Lord Jersey at Teignmouth, and many others), have given it the preference. At a fire at Littleport, one of them pumped water through a hose of one mile length for ten hours to the height of 65 ft.; and for irrigation works there is nothing to equal it.

The Improved Engine, 300 gallons, is a great favourite in country towns and among volunteer fire brigades, being extremely light, mounted on extra high wheels with broad tyres. One of these worked at Hendon for three days, pumping water through a hose of a mile's length over a hill 80 ft. high.

We must not omit to notice Merryweather's Patent Metropolitan Fire Brigade Steam Fire-engine, especially designed for London use at first, but now in general favour. When constructed, in 1874, a great many engineers and gentlemen interested in such matters were present at the testing, which took place at the Lambeth Works in October of that year. Steam was readily raised from cold water within seven minutes of the time of lighting the fire, and water projected 150 ft. Among those who certified to its superiority was the distinguished authority on fire extinction, Captain Shaw, the chief officer of the brigade, to whose suggestions in matters of detail,—such as lowering the centre of gravity, increasing the carrying power, disposition of weight, and the arrangement of the suction and delivery pipes,—the makers are indebted.

It has gun-metal valves and pistons, breechin, and a spacious copper air-vessel; gun-metal cylinders, suction and delivery ways; cross-arm, with two outlets and screws for attaching hoses to; wrought-iron levers with rule joints and sockets to turn over folding levers to the larger sizes. The works are fitted in a strong cistern mounted on horizontal steel springs in front and rear, wrought-iron fore-locking carriage, high wheels, fitted with hose-box, side-pockets and locker to contain and preserve the hoses, suction-pipes, and implements. The engines are so constructed that they can draw water either through a suction pipe or from their own cisterns, and can discharge one or two streams of water as occasion may require.

Competitive trials have frequently been got up, and with results that have increased the fame of this engine. At the Exhibition in 1862 it did its work in half the time of its opponent; at the Crystal Palace International Competition in 1863 it excelled all in the height of its stream—nearly 200 feet. This was the famous engine called "Sutherland," which is now at the Keyham Dockyard, Devonport. It nearly doubled the quantity of water thrown by the others, and with such facility as to require but one-fourth of their speed to win. It filled the reservoir within two hours, which the rest failed to do. So we might add to these the contests at Middleburgh, Utrecht, Amsterdam, Rotterdam, Liverpool, Manchester, Wigan, Nottingham, Bradford, Cologne, the 1867 Paris International (at which the firm received the First Prize and only Gold Medal), Preston, Stockton-on-Tees, Coventry, Barrow-in-Furness, and Moscow, where it obtained the Grand Medal for Progress.

The Stationary Engine (patent double cylinder), for mills, waterworks, steam-vessels, mining, sewage, and general purposes, has fire extinguishing and pumping powers. It is designed to take its steam from the existing boiler of a factory, steam vessel, &c., working at low pressure, say from 10 to 50 lbs. on the square inch, and is much used by the English Government and in the Prussian and other dockyards. This kind of engine is made in several varieties with single cylinders. Then must not be omitted the patent high-pressure stationary steam fire-engine and steam pumping-engine, which work at 100 lbs. to the square inch. These, in one form or the other, are used on board ship and are much praised by such journals as the "Army and Navy Gazette," as affording the promptest assistance in extinguishing fire of any hitherto constructed.

But the subject is not complete without reference to the hand engines, notably the "Prince Albert." Powerful brigade fire engines for insurance companies, fire police, corporations, small towns, docks, mills, &c. It is in the service of fifty insurance offices and twenty-three railways, and one of them (No. 3, £156), built for the London Fire Engine Establishment, now the Metropolitan Fire Brigade, in 1850, threw a $\frac{7}{8}$-in. jet upwards of 130 ft. high, and at the 1851 Exhibition trials in Hyde Park ranged 137 ft., carrying off the First Prize Medal. These require from 30 to 46 men, according to the size selected.

Then should be noted Merryweather's First Class London Brigade Fire-engine, built on the same principle and with the same fittings as those worked by steam. It has won fourteen first prize medals and still higher distinction. Forty of them are used in the London Fire Brigade, fifty in the suburbs of London, and above 500 in the provincial towns. This class of

engine was originated and patented by Messrs. Merryweather, and since the expiration of the patent the principle has been adopted by all first-class fire-engine makers. The London Brigade adopt only two sizes—one discharging 130 gallons per minute, and pumped by thirty men; the other 100 gallons, pumped by twenty men.

We have only space to enumerate the other varieties. These are the Railway Terminus Fire-engine; the Parish, for estates,

plantations, and manufactories; the Village Fire-engine; the Metallic, for hot climates; the Curricle, used by the London Fire Brigade, and costing from £34 to £42—a most useful implement; the Paris, built on the same principle; the Camp, also similar; the Portable, a very old established favourite; another Portable with metallic cistern, which is in great use; the Farmer's, for fires, pumping, and irrigation; the Double-barrel Portable Ship's fire-engine; the India Pump or Fixed; the Long Stroke; and the

Cabinet, which is pronounced by the most competent authorities to be the greatest safeguard against the spread of fire. A commendation of this appears in "The Times" and the "Mechanic's Magazine," and it has been greatly patronized by the nobility and gentry.

Lastly, the small ones, by which "every man is his own fireman," and which are also used as garden engines. Exceedingly simple and of small cost, they ought to be in every large house or factory; because not only are they likely to extinguish a fire, but they assuredly prevent its progress while the large engines are coming on. These are the Cassiobury, the Sutherland, the Lever, the London Brigade Fire Pump and Tozer's Portable.

This article is confined to the notice of the works of one house because, in the first place, it is the oldest and it has won the highest honours; notably, the other day it supplied that, especially tested and capable of sufficient projection in volume and in force, for the protection of Canterbury Cathedral; and also because comparisons of the various merits would extend the observations beyond available limits and could only result in the same conclusions.

THE LOAN COLLECTION OF SCIENTIFIC APPARATUS AT SOUTH KENSINGTON.

II.

AS the season advances the inhabitants of London migrate, and those of the provinces come. A further notice of this great display of modern science is necessary to the resident of the metropolis and of the country, because it may soon be scattered and all its harmony destroyed, leaving only a miserable regret that the opportunity so generously provided had not been turned to a proper account.

One cannot look over this grouping of models, instances, and examples without recognizing the existence of mechanical and scientific perception in the ages long gone by, quite equal in power, but not in the accumulated result, to that which, to some extent, characterizes our own time. The world of language and literature received an inspiration in the sixteenth century; and that may be said of the world of science. The discoveries of our time are few; we have been and are using up the material facts, experiments, and suggestions bequeathed from that age, and at every turn, when, with wondering eyes and delighted intellects, we come upon the knowledge or the recognition of grand truths or facts, we are able to recall the time and find that among the lumber of the past our grand discoveries were treasured or rather scattered. They had not our facility for classification and utilizing; but they could observe and learn to a very clear purpose. One tongue, moreover, described all they knew. The man of science needed no special language to convey the results of his studious toil. The words common to Ben Jonson, Chapman, and Shakespeare sufficed him when disclosing the knowledge appertaining to his department in the school of the universe. We have greatly diverged or departed from such ways, and the departure has been perhaps inevitable; it is, nevertheless, a serious hindrance to the diffusion of knowledge, and should be checked as much as possible. There is no sufficient ground for the departing from ordinary language, which is the habit of modern science; it is not merely the technicality of terms, that must exist and indeed increase, according to the augmented accuracy acquired by study and observation, but it is the mode of thought and style of expression that are to be deplored. Science is fast falling into the snare that has made religion offensive and law despised, by adopting a language and method of speech that are truly as much a slang as any class dialect among the general populace. It saturates scientific lectures, it makes an unknown tongue of scientific papers, and even when a man of culture comes to address a miscellaneous assembly and disclose the wonders that have come within his vision, he has the most painful difficulty in being self-divested of the impediments, or rather incrustations, which have gathered about him, and tended to make a recluse and a foreigner of one who really desired to be a public benefactor. Lectures and documents aim to be popular, but they are not. The general interest is not created in the proportion it should be and might be. Science, like religion, is not worthy of human concern if its disclosures are to be made in an unknown tongue. The jargon of schools never charmed the world, and never can. Practical folk see, and are thankful for, the manifest results of study, experiment, and research; but they would be more enlightened, and more grateful, did the communications come in a form that is accepted and natural, and not technical and artificial. For this reason the public finds great pleasure and instruction in SEEING. Half the explanations that are made in lectures and the like are mere platitudes, which nobody ever disputed, and ought to be held as by everybody understood; and hence that method of teaching the public is resented, to the injury of the scholar, the teacher, and the general culture. But why should not the ear minister to the mind in such matters? Knowledge is better communicated by the combination of seeing and hearing (or reading) than by either in separation.

Mr. Bennet Woodcroft has made contributions to this collection that must obtain for him the thanks of many an unknown observer. The models in "Applied Mechanics" of the steam power loom, of Nasmyth's direct-action steam-hammer, of a circular knitting machine, and a set of models of Chinese agricultural implements, besides fifty others of great interest, are from his treasury, and deserve the careful inspection of those who desire to learn. But as in this paper we wish to make a rapid survey of the other sections, that of Applied Mechanics having been treated in the June number, we pass on.

A great deal of interest has been excited by the revival of Arctic exploration: geography and adventure charm Englishmen under all circumstances, but in exploration our country holds the foremost place. The world of ice has attracted our forefathers, and it has an equal fascination upon us. It should be so. But to have an intelligent appreciation of the subject there must be a large acquaintance with maps of the discovered parts and the routes taken by the travellers. The Arctic collection is one of great and rare value, because it includes all the best of the Royal Geographical Society's maps, such as ancient charts of all nations, and the discoveries down to the time of M'Clintock in 1859; it has from the Admiralty the manuscript chart of Phipps, John Ross's chart of Baffin's Bay, Buchan's voyage to Spitzbergen, Parry's first and second voyages, circumpolar charts of several dates, charts of the lands now mapped, M'Clintock's in manuscript, and the very latest Admiralty charts which have been supplied to the expedition now in the northern ice.

We acquired a taste for geography by becoming acquainted with the Dutch; and it is not only in geography that we have superseded them. In the historical, social, and political position England has beaten her jealous enemy. They had the old chart of the Zeni (14th century) and indeed all other maps, but these England reproduced. There are many in the British Museum bearing the imprint of that nation before we had learned to make a respectable map at all. All our early maps of the Arctic regions are Dutch, but in Elizabeth's time we had begun to make our own; the set exhibited at South Kensington shows the development of our geographical knowledge in the addition from time to time of further shore-lines of the unknown world. When the great army of discoverers, who for England's political distinction did more than Shakespeare and his contemporaries for her literary fame, started from our shores, they never returned without good maps; they surveyed always. Sir Humphrey Gilbert, Sir Francis Drake, and his protégé, Sir Martin Frobisher, with Hudson and Davis, made for themselves an everlasting name in thus investigating the secrets of the world, and mapping out its form, describing its condition, and trading on its resources. We have one loss that cannot be repaired. Baffin, whose name is fixed to a bay in the North-west Passage route, made a map which old Purchas lost or counted worthless; he was the greatest of them all; but it was 250 years before, by the voyage of Sir John Ross, his statements received their vindication and the public acceptance. On one map of 1818 are these words: "Baffin's Bay, according to the relation of W. Baffin in 1616, but not now believed." Ross and Parry in 1818 went into that region, and found that the old man was a true one. Franklin and Buchan branched from them to Spitzbergen, and extended the geographical knowledge, adding also to the worlds of Science and Natural History much treasure, the progress of which is traceable in these exhibited charts, especially in those of Parry, who it will be remembered won the reward of £5,000 by passing the 110th meridian. Franklin, Richardson, and Back's land journeys are well known; the heroic story is not likely to be forgotten. In the circumpolar charts of the Admiralty, 1845, Nos. 18, 19, we learn the extent of Arctic exploration at the time when Sir John Franklin went on his last voyage, and the chart he had for his instructions. With the "Erebus" and "Terror" he made the most remarkable voyage on record, and in the following year made his way round Cape Walker. The brave man died in July, 1847, and the survivors carried on their surveys as they journeyed towards home, establishing the line of continuity hitherto untraced. In the circumpolar charts of 1850 and the following track and chart, 1851, the further acquisitions are denoted; the Austin expedition was followed by that of M'Clure in 1852-4, and the North-west Passage discovered, for they walked it. The "Fox," under Captain M'Clintock, went out when tidings of Sir John Franklin's expedition reached us, and his success in passing the strait and discovering the document telling the sad story of the "Erebus" and "Terror" are well remembered. The growth of knowledge is marked in Arrowsmith's chart. A dozen more of these maps of progress follow in succession, and finally there is that recently issued by Stanford, with the charts sent out with the expedition now in that region, whereby we learn how much has been done and also how much remains to be done.

The same method is adopted with the Antarctic maps: all the voyages are so arranged as to form a perfect self-explaining lecture on the progress of our acquaintance with those desolate regions. This course has been taken also in exhibiting the development of British ascendency from the time of Warren Hastings, who first began Indian geography, to the present time.

Turning from this interesting series, so admirably adapted to impart instruction, the visitor will be repaid for a careful examination of the collection of scientific apparatus connected with geography. These are from the various Government departments: The instruments employed in the Ordnance Surveys of England, Ireland, India and Prussia, and those for sea surveying, are there. The Royal Geographical have contributed Livingstone's last instruments, and several theodolites, sextants, compasses, and barometers, which have been or are now used. To these are added a large collection from various sources, foreign and domestic, of geographical instruments, and all the appliances for carteography and surveying.

The visitor should not omit to inspect 3,154, &c., sent in by the Admiralty. There can be seen Dampier's MS. chart of his voyage to New Guinea; Captain Cook's journal of his all-round voyage, his journal of explorations in the Southern, Indian, and Pacific Seas; Captain Bligh's log on board the "Bounty," with account of the mutiny, and the log of his second voyage on board the "Providence;" Sir John Franklin's log of the "Trent" in 1818; Parry's log of the "Alexander," when searching for the North-west Passage in 1818; his official journals on board the "Hecla" and "Fairy" in 1819-20 and 1821-3; and his log of the "Hecla" in 1824-5.

Also 3,190, which consists of twenty-four MS. maps of celebrated explorers, viz., Livingstone, Erharbt and Redmann, Barton and Speke, Petherick, Speke and Grant, Sir S. Baker, Haywood, and Stanley, ranging from 1850 to 1875.

The Mathematical Instrument departments require specific observation because they contain a large number of precious relics from foreign lands, as well as some of the most venerated objects in our own. There are the telescopes actually used by that apostle of astronomy, Galileo, sent hither by the municipality of Florence; also Sir Francis Drake's astrolabe, used in his first expedition to the West Indies; Sharp's equatorial telescope, 1701, used in the first fitting up of the Greenwich Observatory, where he was employed as astronomer and mathematician, and made not only all the telescopes, but most of the tools used by the joiners, clockmakers, opticians, and mathematical instrument makers. He lived to be ninety-one years of age. There also are Tycho Brahe's quadrant, Napier's (the inventor of logarithms) astronomical quadrant, Coignet's Ptolemy's planisphere (made in 1601, and another a century older), Galileo's compass magnet, another telescope of his, and many other instruments. There is Sir W. Herschell's famous seven-foot telescope, and a ten-foot one of his. Side by side with these stand all the modern examples, except those enormous telescopes which are erected in observatories; these exhibit the progress in construction as well as in the development of knowledge from the old days until now.

Under the class Biology there is a splendid collection of microscopes, to which the same remark is applicable as to the other sections. It is extremely interesting to trace the development of the microscope through the instruments employed by famous men in the course of discoveries which mark epochs in the history of human thought. Here is the microscope made by Ploessl, of Vienna, in 1845, and used by Cohen, of Breslau, in all his researches between 1845 and 1862: this affords an historical proof of the perfection attained by makers thirty years ago, as it was the best in Europe; for near it are the older instruments of Campani's and Musschenbrock, and the superb specimens of the present day.

The vastness of the number of articles under the general classification of Scientific Apparatus precludes all attempt at description; the old and the new are there. Dalton's rough and rude wonderful inventions come from Manchester College; Morland's calculating machine, adapted to trigonometrical computations, made in 1664, Lord Mahon's calculating machine, made in 1775, and the astonishing invention of Dr. Babbage, are there. This last was commenced in 1823, under authority, and at the national cost, with Mr. Babbage's gratuitous supervision. It was suspended in 1833, and abandoned by Government in 1842, after an outlay of £17,000. There is but a part of it put together. Its express design was the calculation and printing of tables, and not to perform single sums; the inventor intended to have had twenty places of figures and six orders of differences. The mode of its operation would require a separate article; the visitor can learn much by a patient inspection, and will leave it with amazement at the enormous power of human ingenuity. There are practical calculating machines, simple and complex, sent in by our present makers, and in contrast is Cavendish's original counting machine.

The study of Drawing Instruments is most useful for general purposes, and the collection here is the most complete ever yet brought together. For instance, pantographs, a large collection of mathematical instruments for geometrical and fortification drawing and for artillery purposes, cases from Paris, Berlin, London, &c. There are instruments for tracing special curves, such as conographs to draw conic sections, elliptic and compound compasses, geometric chucks, and machines for compounding simple harmonic curves. Next are models of figures in space, which were collected for the South Kensington Museum in 1872, models contributed by the Mathematical Society, and a great number from foreign institutes. The measuring apparatus lent by the Standards Department of the Board of Trade comprise every variety of instrument, and these are of astonishing delicacy and exactness; they cannot err. The whole business is exposed to view, whether in standards of length, or weights and measures, used in England and in Paris, and a large number of specimens of various instruments connected with the subject, from the most minute to the largest; added to which there are the Winchester bushel and gallon, given to the corporation of Winchester by Henry VII. as the standard; the standard gallon, quart, and pint of Queen Elizabeth, dated 1601; the standard quart and pint of William III., and the standard weights of Edward III. and Queen Elizabeth.

Sir Joseph Whitworth forwards a valuable contribution, including his measuring instrument graduated to measure one-millionth of an inch; another graduated to measure one ten-thousandth of an inch, and several gauges. There is an excellent selection sent from Germany, consisting chiefly of apparatus for measurement, which must be inspected rather than described; it includes compass meter-scales, standard meters, dividing machines, planimeters, and the like. In all the forms of measurement the same remark applies. Balances in every variety seem to be a successful manufacture there. An old Roman steel-yard, which was dug up near Cirencester about twenty years ago, may be compared with the fifty or sixty new ones of every possible variety in size and application.

Then we see patent logs, water meters, velocimeters, apparatus for indicating by electricity a ship's speed, electric chronographs, clock-chronographs, anemometers, &c.; after that pendulums, gyroscopes, &c., *ad infinitum*.

The collection of Kinematic models exhibited by Professor Resleaux was noticed in our last when reviewing Mr. Kennedy's translation of the learned Professor's book on Kinematics. The young engineer possesses herein materials for study he can never too highly appreciate. The number of the separate models is 300, and they include all that are required for the illustration of the Professor's theory of machines.

Those engaged in the practical sciences and in manufacture will have much satisfaction in inspecting the Pneumatic and Hydrometric apparatus, consisting of compressers, pumps, and instruments employed in connection therewith—for instance, to ascertain the quantity of moisture in the air or the quantity of salt in sea-water, or for ascertaining the proof strength of spirits; aërometers; indicators to ascertain the quantity and depth of water in a deep well—artesian or other. These are modern, but are entitled to the regard of every one engaged in occupations requiring a tolerable acquaintance with general mechanical forces.

We must pass over the great store of objects in the department of Electricity and Magnetism, and indeed bring these remarks to a close. A great gain has resulted from the work we have so briefly described, and the conferences and lectures which have ensued are not among the least of those results. At the first of these Mr. William Spottiswoode, M.A., LL.D., spoke with singular propriety and force on the general question, and with his observations we close this paper:—

"We have gathered together a collection of valuable instruments from all parts of the world—instruments that were not only models of ingenuity and workmanship, but evidences of deep intellectual thought. This was the first serious—or at all events the first successful—attempt at a cosmopolitan exhibition of the kind, and I felt we must all be grateful to the English and foreign societies and institutions that have contributed their aid. Many instruments of historical interest have been contributed, but a museum consisting entirely of relics of the past would have possessed comparatively little value in an educational sense. In contemplating them side by side with the elaborate instruments of modern time, we might be apt to wonder how our past philosophers achieved their brilliant discoveries with such crude means at their disposal. While, however, the early germination of a great theory or discovery was in progress, comparatively rough means might illustrate its main truths and outlines. It is in its later development and reduction to scientific accuracy that we need the beautifully delicate and complicated apparatus that we see around us. I threw out the suggestion that such of the apparatus as was no longer of practical use might be left at South Kensington on permanent loan, and I think, moreover, that many societies and individual owners might be glad to avail themselves of a national repository for valuable instruments in their possession. However that might be, we have collected not only a magnificent show of valuable instruments, but also a number of the men whose powers had led up to their conception and development."

That so good a conception may become a permanent institution is most earnestly to be desired, and it is with sincere gratification we observe indications that, by the joint efforts of the Government and the Commissioners of the Exhibition of 1851, there is a very fair prospect of so great a benefit being conferred upon the world of science, art, and manufacture. There are doubtless disadvantages in concentrating precious relics into one location, but the advantages are greater. Museums, to be of practical value, must be very large, and have the confidence and co-operation of the whole nation, besides such extraneous aid as the courtesy of neighbouring nations can give, either by duplicate models or loans in exchange.

SIMPLIFICATION IN GALVANIC BATTERIES.

THE following account of some improvements in galvanic batteries, intended to render them easier and therefore cheaper of construction, and more portable in a variety of cases in which an ordinary battery would be inadmissible, is taken from the *Comptes rendus* of the *Académie*:—

"The improvements consist in the substitution of artificial parchment for the diaphragm or porous jar, and in the simple arrangement of the different portions of the battery. The paper parchment, on account of its suppleness, readily lends itself to any form; it has only a small volume, and acts as a dialyser as efficiently as porous earthenware. The sulphate of copper battery, for instance, thus becomes one of great simplicity, and may be put in action at any time. All that is necessary is to wrap a sheet of paper parchment round a zinc cylinder and to roll a copper wire spirally round the parchment, thus forming a diaphragm. The whole is plunged into a solution of sulphate of copper, and the battery immediately works with regularity, all the parts thus constituting a small cylinder hardly longer than the zinc rod employed.

"In the case of some carbon batteries a similar arrangement may be adopted: the carbon may be enveloped in the paper parchment, and on the outside may be placed a cylinder of zinc or a thick zinc wire, which serves at the same time to keep the paper in its place. When the battery thus constructed is wetted it is capable of continuing in action for some hours after being taken out of the exciting liquid; and it may be rendered more portable, and be endowed with all the advantages of a dry battery, by folding the paper double and placing the exciting salt between the folds. This modification has also the advantage of giving with a single liquid the effect of a two-liquid battery. In fact, on immersing this battery in an exciting liquid a difference is immediately set up between the latter and the liquid which has penetrated into the interior and occupied a place between the paper and the metal covering."

Practical Literature.

USEFUL RULES AND TABLES RELATING TO MENSURATION, ENGINEERING, STRUCTURES AND MACHINES.[1]

THIS is a new and revised edition of a well-known manual for engineering purposes. It comprises in moderate bulk a collection of rules and tables relating to those parts of mathematical and mechanical science whose application most frequently recurs in the useful arts, and more especially in engineering and practical mechanics, embracing arithmetic, mensuration, measures, under which head is included not only

[1] *Useful Rules and Tables relating to Mensuration, Engineering, Structures, and Machines.* By William John Macquorn Rankine, C.E., LL.D., &c. &c. Illustrated. Fifth Edition, thoroughly revised by Edward Fisher Bamber, C.E. London: Charles Griffin and Co., 1876.

measures of angles, time, length, surface, volume, weight, and value, but those quantities more or less complex, such as speed, heaviness, pressure, work, power, moment, absolute force, and heat. There are also tables relating to engineering geodesy, distributed forces and mechanical centres, the balance and stability of structures, including frames, chains, and arched ribs, retaining walls, piers and abutments, arches of masonry, and foundations of different kinds. Tables are further given as to the strength of materials, machines in general, hydraulics and marine engineering, and heat and the steam-engine. This last section of the work is a most important and valuable one. It contains "a system of rules and tables founded on the true principles of thermodynamics for determining the relations between work done and heat expended in any actual or proposed steam-engine. These are followed by rules for fixing the leading dimensions of the principal parts of an engine required to do a given duty under given circumstances; for the heating power and the expenditure of fuel; for the efficiency and dimensions of furnaces and boilers; and for the proportioning of slide-valve gear, link motions, and other fittings of steam-engines." To this is added a plate containing a pair of diagrams of the mechanical properties of steam, by the use of which much labour in calculation may be saved.

The work is fully illustrated wherever illustrations are needed, and a careful and exhaustive index is given.

PRACTICAL PORTRAIT PHOTOGRAPHY.[1]

PHOTOGRAPHY is a subject which possesses special attractions for amateurs, and notwithstanding the scorn with which the work of the amateur is often regarded by the professional operator, many of them have succeeded in producing excellent results. We need only point in confirmation of this to the excellent pictures produced by Mrs. Julia Margaret Cameron, whose recent magnificent volumes of illustrations to Mr. Tennyson's poems are now so well known. Mr. Heghway's book is a book written by an amateur for amateurs, and is bristling with practical hints, many of which, it is true, seem to us to be superfluous, but, on the other hand, there are many—and by far the larger proportion of them are included under this head—which cannot fail to be of service as well to the beginner as to the more practised operator. The style is clear and simple, the book is portable and handy, and will no doubt find favour with those for whose use it is intended.

SANITARY WORK IN THE SMALLER TOWNS AND VILLAGES,[2] AND PLUMBING.[3]

THE constantly increasing attention which has of late years been given to the improvement of the sanitary condition of our over-civilized mode of existence is one of the most gratifying signs of the times. The pure light of scientific investigation is poured in upon all the details of our every-day life, and the result cannot but be beneficial to our bodily and mental welfare. As an instance of this, we need only point to the recent notorious outbreak of scarlatina at South Kensington, where, in one house, a large number of persons were attacked by this disease, and, after a most elaborate and searching inquiry, its origin was clearly traced to the cream which was used in that house on a particular day. Although in this instance no practical remedy against a recurrence of such an outbreak was established, yet the conditions under which such an investigation is possible must certainly be far more healthful than in days gone by, when no effort would have been made, owing not only to the apathy of our forefathers in such matters but to the want of the scientific knowledge requisite to pursue so exhaustive an inquiry, to trace the evil to its source.

The two books which we have named at the head of this article, although not bearing directly upon the branch of the subject to which we have referred, deal nevertheless, the one entirely and the other incidentally, with the important question of sanitary works, viewing it more particularly with reference to our times and their surroundings. As Mr. Slagg truly says: "The end and aim of all sanitary work is to get rid of the dirt in the midst of which we live; for it poisons the air we breathe, the water we drink, and in some measure the food we eat. It consists chiefly of that which we cast off from us through the four channels of discharge, all of which should be exposed to the action of the earth or of the air, or of both, as wholly and as quickly as possible after it has been thrown off, in order that it may be oxidized and otherwise changed into substances not injurious to animal life. This effete organic matter which we throw off is, during the progress of decomposition into its elements, a nuisance, and therefore injurious." When to these remarks we add, that his book deals with those *constructive* works which are approved as preventing disease, the aim of his work will be indicated, although broadly, with sufficient completeness and accuracy. We shall refer to it more in detail later on.

The work by Mr. Buchan, notwithstanding that it has chiefly in view the requirements of the apprentice plumber, and is intended to afford him a handy text-book explaining the mysteries of his craft, to a large extent supplements and completes the work of Mr. Slagg; for with the exception of some of the works upon the exterior of the house, Mr. Buchan's book deals also with those "constructive" works in our dwellings which are employed to prevent disease. "Sanitary Work" is divided into three parts, which treat of some of the more common forms of nuisance and their remedies, such as pig-styes, slaughter-houses, privies, cesspools, bad air, dirtiness in houses, dampness in houses, the storage of rain, the contamination of well-water. The second part treats of the important question of drainage, embracing house-drains, sewers, arrangements of out-buildings of small houses, paving materials, the composition and disposal of sewage; and the third part deals with water supply—its quality, quantity, and sources, the methods of gauging it and of conveying it to its destination.

We must refer our readers to the work itself for the many valuable remarks and suggestions on all these subjects with which it abounds, but there is one important principle laid down by our author at the outset to which we recommend their attention. It is, that "The value of sanitary works is not measured by the amount of money they cost, but by their being adapted to the requirements of the case." Although this may seem to be almost a truism, yet we have seen such a lamentable expenditure of time and money upon elaborate systems of drainage, and other sanitary arrangements which have been altogether useless, and on the other hand so much evil resulting from an unwise parsimoniousness, that we cannot but feel the principle is by no means so widely recognized as it should be. A careful study of the requirements of the case, and, having ascertained them, sparing no expense to meet them, is, we feel confident, the most economical plan in the end. The best way of determining most if not all of these requirements, and the most efficient methods of dealing with them, will be learned from Mr. Slagg's useful little book.

The importance of the plumber's work in securing such sanitary perfection in the house as is possible with modern appliances can be questioned by no one, and as Mr. Buchan truly says, "there are few things in connection with modern houses of greater interest or more worthy of careful consideration, so far as the comfort and health of the tenants or inmates are concerned, than the character of the plumber's work." The thanks therefore, not only of the craftsman for whom his work is written, but of heads of families everywhere, are due to him for his most useful and thoroughly practical little volume. While the apprentice and master plumber may, nay, in every case ought to possess his work, it will be found useful to the householder as showing him the best methods of avoiding those inconveniences so plentiful in modern houses, owing often, we admit, to the reckless manner in which houses are now built—simply to let, but not to live in—but quite as frequently to the carelessness or incompetency of the men entrusted with the carrying out of the practical details of the plumbing. Both these works, then, deal with subjects of immense importance, they are both executed with care, and evince a thorough practical knowledge of the subjects on the part of their authors of which they treat; and we trust that, in the interests of the public morality as well as of the public health, they will speedily secure a wide circulation.

[1] *Practical Portrait Photography: A Handbook for the Dark Room, the Skylight, and the Printing Room.* By William Heghway. London: Piper and Carter, 1876.

[2] *Sanitary Work in the Smaller Towns and Villages.* By Charles Slagg, Assoc. Inst. C. E. London: Crosby, Lockwood and Co., 1876.

[3] *Plumbing: A Text Book to the Practice of the Art or Craft of the Plumber. With supplementary chapters upon House Drainage, embodying the latest improvements.* By William Paton Buchan. Illustrated. Crosby, Lockwood and Co., 1876.